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FORAMINIFERA AND BIOSTRATIGRAPHY OF THE DANIAN AND MONTIAN IN POLAND

(OTWORNICE I BIOSTRATYGRAFIA DANU I MONTU POLSKI)

BY

KRYSTYNA POŻARYSKA

(WITH 28 PLATES, 9 TEXT-PLATES AND 6 TABLES)

WARSZAWA 1965

PAŃSTWOWE WYDAWNICTWO NAUKOWE

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CONTENTS

INTRODUCTION

The aim of the present paper is to analyse the microfaunal foraminiferal assemblages from the boundary of the Cretaceous and the Tertiary in Poland, the Carpathians excluded. A stratigraphic delimitation of the Maastrichtian, the Danian and the Paleocene may then be attempted on the basis of these assemblages and sedimentological investigations.

No comprehensive sedimentological analogies with the Danian of Denmark have been reported from any other region which makes an accurate delimitation of the Danian in other countries extremely difficult. The development of the Danian in Poland differs considerably from that in Denmark. However, owing to Poland's near geographical position, and also probably to the convenient seaways between the two sedimentological basins, their microfaunas are closely related. These facts constitute a good basis for a more accurate biostratigraphical investigation of the Danian in Poland. It permits at the same time to obtain a more accurate definition to the term of Danian, in the sense used for it in the type region of Denmark and southern Sweden. Unfortunately, up to now no monographic description has been published of the Danian microfauna of Denmark and from the few papers available, only a score or so species of Danish foraminifers are known and there is no information as to their vertical extent within sediments that overlie or underlie the Danian deposits.

The present paper contains a description of about 150 species of foraminifers from the Danian and the Paleocene of Poland. Such an accumulation of material characterizing the Danian stage could provide a broad basis for further investigations of deposits of this age in other parts of Europe, namely deposits from the boundary of the Cretaceous and the Tertiary. So far, this applies only to the European areas lying north of the Alpine geosyncline.

The present work has resulted in the establishment of the independence of the Danian stage though, indeed, this does not markedly differ from the Paleocene due to the lack of thickness of the deposits in Poland outside the Carpathian region, the scarcity and bad preservation of the macrofaunal fossils, the nature of the foraminiferal microfauna and the extreme monotony of the lithological development. In the United States of America the Danian has been included into the Paleocene as its oldest stratigraphic member. Establishing the Danian as a separate stage therefore called for a particularly full analysis based on all reasonably acceptable suggestions.

The writer's palaeontological studies on the Danian and Paleocene deposits of Poland were carried out between 1957-1962. The field work consisted in sampling rocks from the banks of the middle Vistula valley between Kazimierz and Puławy where outcroppings of these beds are to be found, and scientific inspection of the borings drilled by the Institute of Geology at Góra Puławska, Żyrzyn and Sochaczew. The boring at Góra Puławska drilled in 1949 has been described and sedimentologically elaborated in a previous paper (POŻARYSKA, 1952). The extremely rich palaeontological material recovered from the heap at the Boryszew boring near Sochaczew in 1955 has provided the basic data for the study of the Danian and Paleocene

deposits, and has shown the presence in the Polish Lowland of *Crania tuberculata* s. l. (ROSENKRANTZ, 1964) beds, assigned to the Lower Paleocene on the base of its foraminiferal remains (POŻARYSKA, 1964).

Thanks to additional borings in central Poland: at Sochaczew, very near Boryszew, at Magnuszew, at Żyrzyn in the western part of the Lublin region, and at Pamiętowo (northern Poland), it was possible to determine more exactly the date of these beds by means of faunistic and sedimentological correlations (Text-plates III-VII). The preliminary study of the borings at Boryszew and Pamiętowo by BROTZEN and POŻARYSKA (1957, 1961) has been particularly useful in this respect.

All the more important foraminiferal species in the Maastrichtian, Danian and Paleocene from the above mentioned borings and exposures have been recorded by the writer. In order to emphasize the boundary between the Maastrichtian, Danian and Paleocene stages these species are listed in Tables 1 and 2 showing the stratigraphic distribution for this area. A separate list of the index foraminifers for these three geological stages has been drawn up to give a clearer stratigraphic picture (Text-plate VI).

In the chapter on systematics, mainly the Danian and the Paleocene, chiefly the Montian species, have been described and figured, as the present paper is mainly concerned with these two stages. No description of species from the genera *Lagena* and *Fissurina* is given since they do not differ from those previously described by the writer (POŻARYSKA, 1957). In all, 150 species have been identified, including one new species. The material described is housed in the Palaeozoological Institute of the Polish Academy of Sciences, under the catalogue number F VI/1-155.

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The present paper was prepared thanks to the Geological Institute in Warsaw, which kindly made available the necessary materials from borings. Thin sections for sedimentological purposes were prepared in the Laboratory of Lowlands (Geological Institute).

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It was with the help of the Polish Academy of Sciences that the writer was able to visit in 1956-1962 various European countries where the Danian and Paleocene deposits are developed.

The author particularly wishes to express her indebtedness and cordial thanks to Dr F. BROTZEN (Swedish Geological Survey, Stockholm), and to Professor Dr A. ROSENKRANTZ (Institute of Geology and Mineralogy, University Copenhagen), who introduced her to all

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Palaeozoological Institute
of the Polish Academy of Sciences
Warszawa, February 1964

GENERAL PART

HISTORY OF INVESTIGATIONS IN POLAND

Opinions advanced during the 19th century, up to 1891, by Polish geologists of that period (PUSCH, JURKIEWICZ, SIEMIRADZKI) concerning the geology of the area under discussion were contradictory and are not quoted in this paper. The glauconite »siwak« beds resting on the »opoka« were assigned either to the Lower Cretaceous or Cenomanian in the belief that these beds plunge southwards. KRISZTAFOWICZ (1899) was the first to interpret correctly the geological structure of the vicinity of Kazimierz and Puławy. He differentiated several rock series, the uppermost consisting of sandy-glauconitic deposits, with accumulations of harder calcareous rocks called the »siwak« rock. Owing to the scarcity of the fauna which did not yield any reliable age marks for the rock series, KRISZTAFOWICZ referred it to transitory rocks on the boundary of the Cretaceous and the Tertiary. The »siwak« beds rest on marly limestones containing at the top sandy-glauconitic intercalations that grade downwards into white chalk-like marls. The fauna of these limestones is rich and contains the index form *Scaphites (Hoploscaphites)* [1] *constrictus*, by KRISZTAFOWICZ assigned to the uppermost Senonian.

SIEMIRADZKI in his later papers (1905) referred these »siwak« beds to the Danian, while the underlying »opoka« beds were dated as Maastrichtian. In 1931, on macrofaunal evidence SIEMIRADZKI decided to assign Lower and Middle Eocene age to all the sandy-glauconitic series overlying the »opoka«. He did not at that time differentiate the Paleocene but identified it with the lowermost horizons of the Eocene. The underlying »opoka« of Kazimierz was recognized by SIEMIRADZKI as an equivalent of the »opoka« of Lwów (Lvov, U. S. S. R.), i.e. as uppermost Maastrichtian.

In 1931, on the presence of several forms of pelecypods and gastropods that belonged either to the Senonian or the Paleocene, MAZUREK supported SIEMIRADZKI as to the Danian age of the »siwak« rocks. In a later paper (1932) the same author assigns the »siwak« series to the Paleocene, while another »siwak« series overlying a sandy-glauconitic bed with phosphates is referred by him to the Danian.

In 1935 MATWIEJEWÓWNA published a paper on the fauna of pelecypods and gastropods in the »siwak« beds including a plate of the faunal assemblage. More than half of the 80 species identified by MATWIEJEWÓWNA were marine forms and this not unreasonably led her to assume that the lower part of the »siwak« beds represented the Danian, while the Montian was represented by the higher strata. The glauconitic sandstone containing an admixture of phosphates was assigned by that author to the uppermost Maastrichtian.

In a paper on echinids, cephalopods and brachiopods published in the same year, the

[1] See T. BIRKELUND: Ammonites from the Upper Cretaceous of West Greenland. — *Medd. Grønland*, Bd. 179, No. 7, København 1965.

stratigraphic conclusions of KONGIEL (1935) corresponded to those of MATWIEJEWÓWNA, the Montian however being identified by him with the Upper Danian.

In 1938, during investigations of the river gorge in the valley of the middle Vistula, POŻARYSKI established the stratigraphy of the monotonous Upper Cretaceous series as a number of local stages and horizons. He thus differentiated a phosphate layer in the bottom of the »siwak« beds, with numerous *Belemnitella*, as the »z« horizon (uppermost Maastrichtian), while the underlying »opoka« bed was called by him the »x« horizon. On the base of numerous *Belemnitella* remains in the »z« horizon he assigned it to the uppermost Maastrichtian, while the underlying limestones were recognized as the »y« hard ground.

KONGIEL stated in a paper (1949) devoted to a comparative study of the genus *Echinocorys* from the Danian of Denmark, Sweden and Poland, that the echinid fauna of the »siwak« beds has an endemic character not found elsewhere with the exception of 3 species from the Danian of the Crimea, the Caucasus, and the Upper Cretaceous of Belgium and northern Germany. He assigns the »siwak« beds to the Danian, the glauconitic sandstone to the Upper Maastrichtian, and the underlying »opoka« series to the Lower Maastrichtian.

It is interesting to note that echinid remains of the genus *Tylocidaris*, so characteristic of the Danian of Denmark and Sweden, have never been found in the »siwak« series, however, they were found recently by W. POŻARYSKI in the boring at Boryszew near Sochaczew and subsequently described by KONGIEL (1958), who stated the Danian age of these beds, ROSENKRANTZ being of the same opinion (1964). RÓŻKOWSKA (1956) describing coral remains from the same boring noted the Montian age of the sediments in which the corals were found.

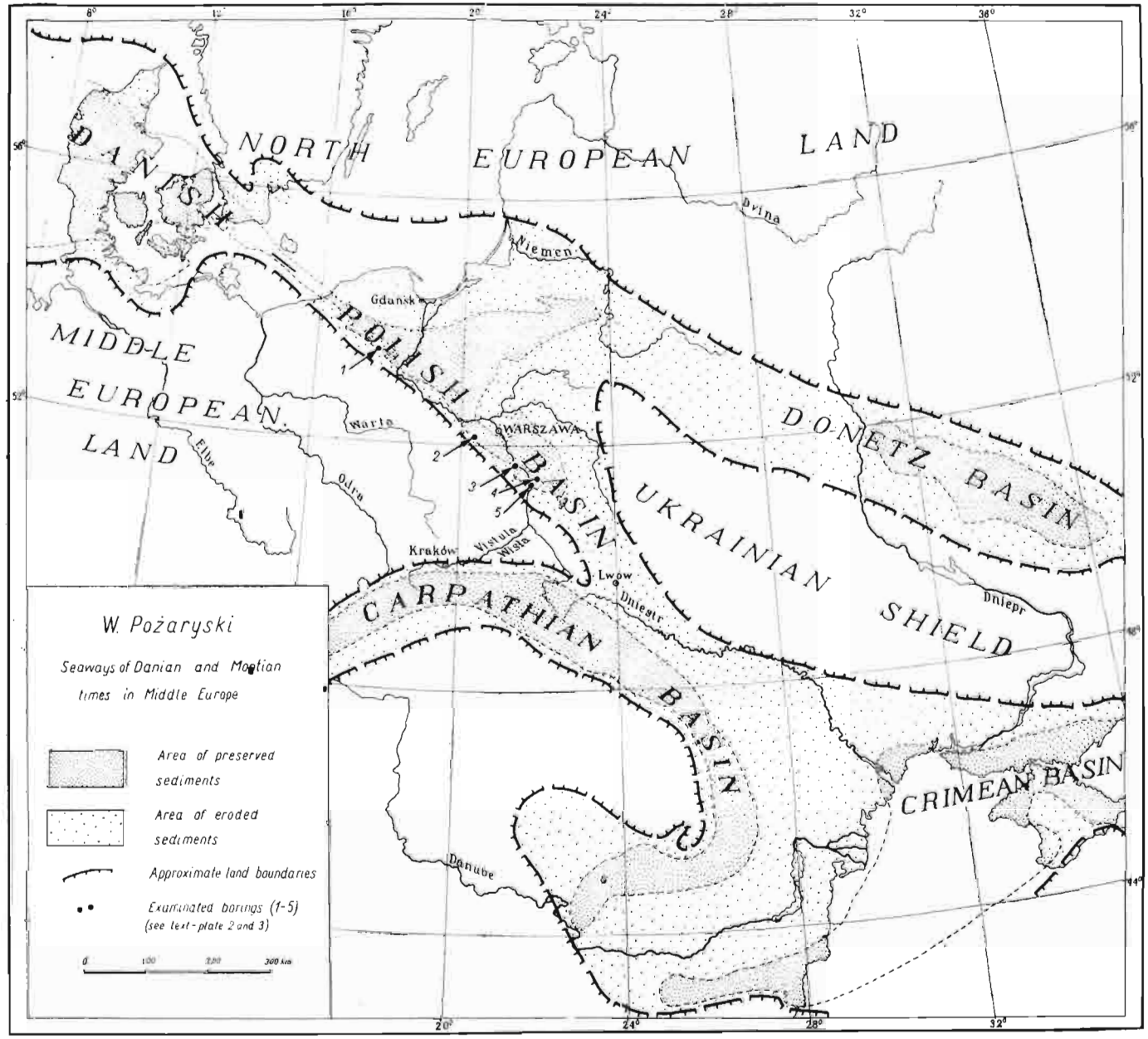
Lastly in a preliminary note on this same boring, BROTZEN and POŻARYSKA (1957) state that the foraminiferal assemblage found there closely resembles that reported from the Paleocene of Denmark and Sweden. VOIGT (1964), who recently studied the Bryozoa from the same boring, considers »the beds under discussion as transition beds between Danian and Paleocene or as lowermost Paleocene«.

GEOLOGICAL SETTING OF THE DANIAN AND PALEOCENE MICROFAUNA IN POLAND, THE CARPATHIANS EXCLUDED

(Text-plate I)

The marine deposits from the boundary zone of the Cretaceous and the Tertiary of central Europe occur as a belt running NW-SE traversing central Poland. They occupy the western margin of the East-European platform and represent the marine remnants of the Danish-Polish geosyncline. They outcrop in the vicinity of Puławy and Lublin, while in the southern part of the Lublin region they have been eroded. In the opposite direction, i.e. to the north-west, these deposits dip below sediments of the Oligocene and Miocene, and have been reached in borings at Góra Puławska, Żyrzyn, Magnuszew, Boryszew, Sochaczew, Pamiętowo etc.

The writer's observation points were grouped in three regions along a line running in a NW-SE direction. This line is the axis of the marginal synclinorium that forms the SW-margin of the East-European platform (POŻARYSKI, 1957). Part of the deposits here rise to the surface of the platform, tapering towards the north-east. They are truncated by erosion from the south-west owing to the presence of an anticlinorium bordering the platform that was upheaved during the Laramide orogeny.



SEAWAYS OF DANIAN AND MONTIAN TIMES IN MIDDLE EUROPE

The marginal synclinorium encircles the platform, from the Jutland peninsula across the Danish islands, south-western Scania, Pomerania, central and south-eastern Poland, and then along the borders of the south-western Ukraine, particularly noticeable along the margin of the Ukrainian massif to Crimea and the northern forefield of the Caucasus.

During the Upper Cretaceous the marginal synclinorium was a sea basin which diminished gradually towards the close of the Cretaceous but retained a continuity of sedimentation at least until the Lower Paleocene. It was connected with the large basin of the Tethys sea at the point where it turned from the south-western to the southern border of the platform which contacted with the Alpine geosyncline area. This point must have been situated somewhere within the Carpathians of the western Ukraine. The Danish-Paleocene transgression persisted also in the depressions of the central part of the Russian Platform, mainly in the northern and western extension of the Caspian depression to the lower Volga, and in the Dniepr-Donetz basin. The last named was perhaps a direct route of communication between the Volga basin and northern Poland. This supposition cannot, however, be fully confirmed owing to the absence in Belorussian S. S. R. of Danian and Lower Paleocene deposits. Deposits of this period are likewise missing from the marginal synclinorium in the south of the Lublin region and Lwów (Lvov). There may be some doubts as to whether the Danish-Paleocene sea, and northern and central Poland were connected with the Crimea via this route, yet the existence of a sea within this area at the Cretaceous-Tertiary boundary is reasonably suggested by the presence of a synclinorium throughout the Upper Cretaceous and part of the Tertiary, as well as by the repeated occurrence of erosional phases during the Paleogene.

Throughout all its extension the marginal synclinorium occurs within the East-European platform and its Danian-Paleocene sediments have an epicontinental, regressive character. They all display the same shallow-water type of facies. These deposits are represented either by reefy or reefy detritic sediments (Denmark, Crimea) certainly by sediments containing numerous bryozoan remains (Denmark, Sweden, Poland) and terrigenous material, which is present in greater abundance than in the Maastrichtian, accompanied by a considerable amount of glauconite, locally also by phosphates. Sporadically, the facial development is that characteristic for the Upper Cretaceous, e.g. the chalk intercalations in Denmark or those of the »opoka« type in Poland.

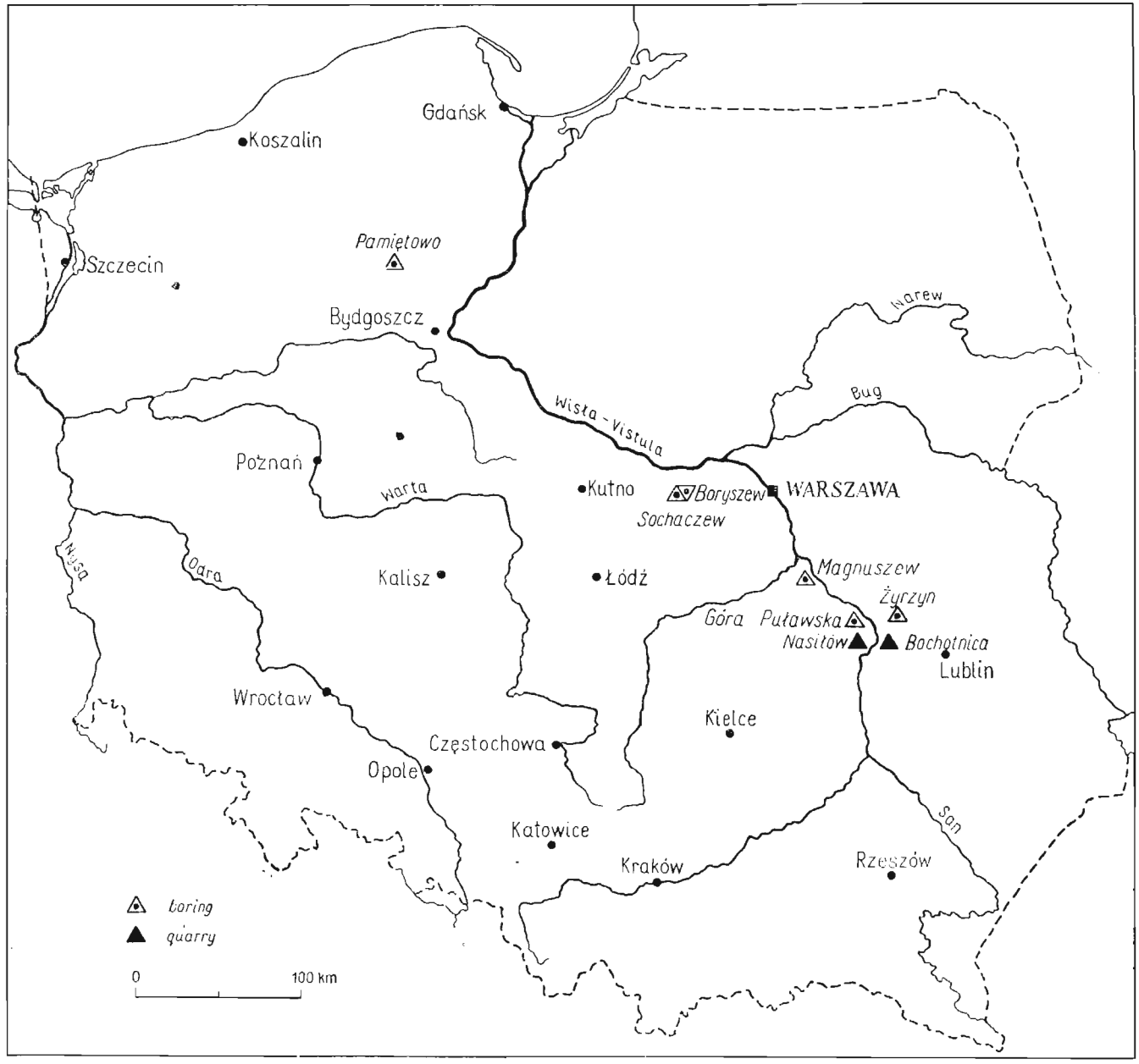
All these deposits are moreover characterized by a rhythmical repetition of changes in the sedimentation, expressed by the alternating occurrence of more calcareous or less calcareous sediments at a distance of some tens of centimetres to several metres. This rhythm is a constant feature found in deposits of that age in Denmark, Poland and Crimea, as well as in Belgium and the Netherlands (POŻARYSKA, 1952, W. & K. POŻARYSKI, 1959).

LOCATION OF OUTCROPS AND BORINGS

(Text-plates I-II)

This present paper is based on data supplied by 5 borings grouped in 3 regions. The first in the vicinity of Puławy and Żyrzyn, the second at Sochaczew, and the third at Pamiętowo.

1st region — *Pulawy* — is situated on the middle course of the Vistula, in central Poland. There the marginal synclinorium changes its character and, from a relatively strongly upheaved area in the south, passes into a deep depression towards the north-west. South of Puławy the Danian deposits, on entering an area with a tendency to upheaval, are greatly reduced (Bochot-



BORING AND QUARRY SITES IN CENTRAL AND NORTH POLAND

nica, 8 km. south of Puławy). Towards the north the deposits increase in thickness as have been observed in the boring at Żyrzyn (12 km. north-east from Puławy) in relation to that at Góra Puławska.

2nd region — *Sochaczew* — lies 60 km. west of Warsaw, where the marginal synclinorium widens out to the axis of the Podlasie depression which is the western prolongation of the Dniepr-Donetz depression. The boring at Boryszew is 300 m. from the Sochaczew boring.

3rd region — *Pamiętowo* near Chojnice — is situated in northern Poland, on the border of the synclinorium, hence deposits of the Danian have probably been strongly reduced, while those of the Upper Maastrichtian are eroded.

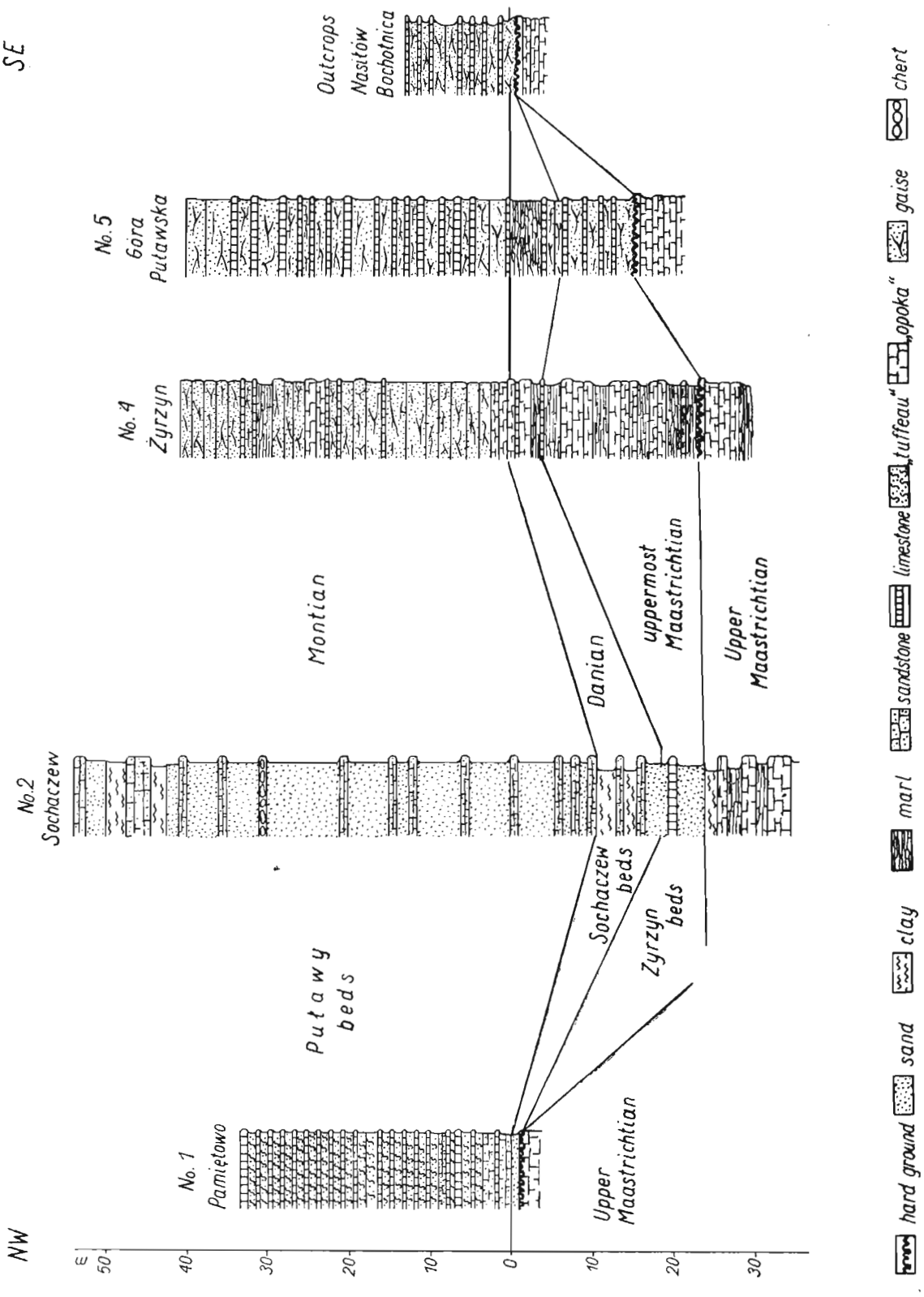
A tabulated list of the microfauna under consideration (Tables 1 and 2) was drawn up as follows: The foraminifers are arranged into families and genera according to CUSHMAN'S systematics, the arrangement within each genus being based on the stratigraphy. The vertical distribution of the foraminifers is complicated by the presence in the Danian and the Paleocene of earlier forms reworked. In view of the regressive character of these stages, a considerable part of the area lying south-west of the region under discussion and occupied by Maastrichtian and Senonian deposits was probably upheaved during the Danian and the Paleocene. This elevated area supplied abundant detritic material yielding foraminifers which occur in great numbers within these sediments. Thus the Cretaceous rocks were subjected to strong erosion and this may reasonably explain the presence of a relatively large number of redeposited foraminifers. This applies particularly to the samples of the lower part of a given stage, which are often contaminated having many reworked species. On the other hand, since the facial differences here between the geological horizons are relatively small, the range of some foraminifers does not exactly correspond with the boundary of a given stage, but either passes beyond it or ends somewhat earlier.

142 species have been listed in Tables 1 and 2. Species encountered sporadically and those occurring en masse as reworked specimens, like *Rugoglobigerina rugosa* and *Globotruncana* sp., are omitted in descriptive part.

The vertical distribution of the foraminifers in the three borings under consideration (Góra Puławska, Sochaczew, Żyrzyn) indicates two distinct stratigraphic boundaries, i.e. the Maastrichtian-Danian and the Danian-Paleocene. The first named, lower boundary, is particularly distinct, being characterized by the appearance of 72 species, while 20 species make their appearance at the higher, Danian-Paleocene boundary. These boundaries cannot be so clearly delimited by the disappearance of certain species. The lower boundary is indicated by the extinction of over 80 Upper Maastrichtian species, while the upper boundary is characterized by the extinction of just 6 species. The horizon enclosed by these boundaries do not contain a single foraminiferal species whose occurrence is restricted only to this stratum. Thus there are here three horizons overlying the hard ground surface of the Upper Maastrichtian. One occurs between the hard ground surface and the lower microfaunal boundary and will be referred to as the »Żyrzyn beds«, since in the Żyrzyn boring these beds are the best developed. The second horizon occurs between the top and bottom microfaunal boundaries called here the »Sochaczew beds« as they attain their maximum thickness in the boring Sochaczew. The third horizon the »Puławy beds« or the so-called »siwak beds« overlies the upper microfaunal boundary.

The first two horizons have so far never been recorded from surface outcrops, but only from borings, while the Puławy beds include all the previously reported »siwak«, throughout the whole Lublin region, particularly those at Bochotnica, Nasiłów and Góra Puławska. The Żyrzyn beds are the oldest and rest on a limestone layer a 1 m. thick — typical hard ground. The limestone is exposed south of Puławy where it has been described by POŻARYSKI (1938)

TEXT-PLATE III



CORRELATION OF BORINGS AND OUTCROPS IN CENTRAL AND NORTH POLAND

as horizon »y«, its macrofauna containing index forms for the higher Upper Maastrichtian horizon: *Belemnella casimirovensis*, *Scaphites (Hoploscaphites) constrictus*, *Sphenodiscus binckhorsti*, *Inoceramus tegulatus*, *Baculites* sp. etc., its age being additionally confirmed microfaunally by the presence of *Neoflabellina reticulata*, *Cibicides bembix*, *Bolivina incrassata gigantea*, *Bolivinoides draco draco* et al.

ŻYRZYN BEDS — UPPERMOST MAASTRICHTIAN

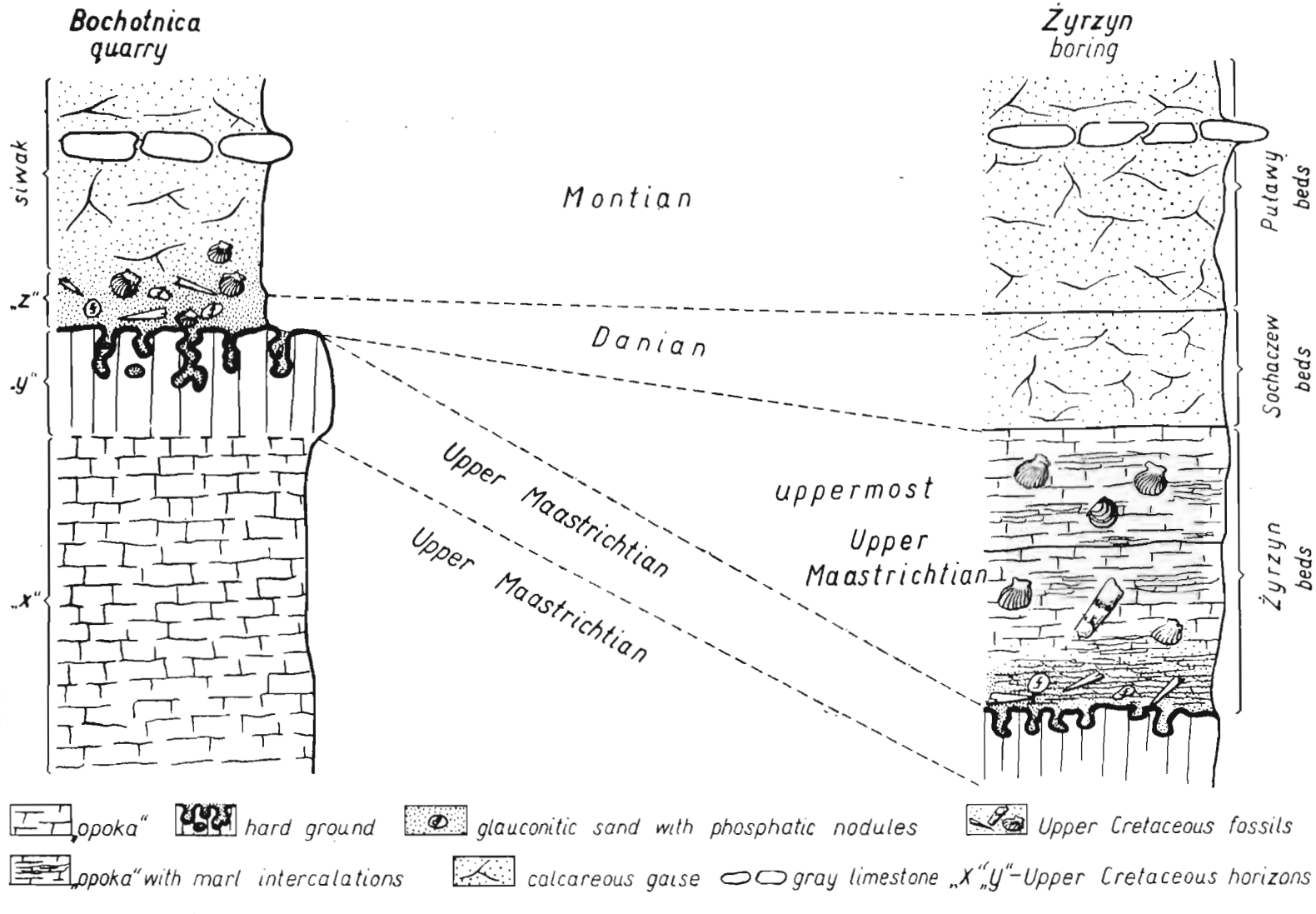
(Text-plates III-IV)

The Żyrzyn beds lying on a hard ground limestone layer are represented by glauconitic »opoka« at Żyrzyn and by limestone gaizes at Góra Puławska. In both localities they are intercalated by rather hard marls. At Sochaczew they are represented by sandy-marly clay and marly-glauconitic sand with considerable bryozoan remains. Both at Sochaczew and Żyrzyn there is an abundance of macrofaunal remains. The bottom of the Żyrzyn beds on the hard ground surface is crowded with belemnite rostra, having as many as several hundred specimens to a square metre. Moreover, they contain fragments of baculites, inoceramids and numerous pelecypods of the Maastrichtian type. The Żyrzyn beds are 19·7 m. thick at Żyrzyn, 5·7 m. — at Sochaczew, and 9·5 m. — at Góra Puławska; they are preserved only as remnants at Bochotnica and Pamiętowo. This indicates that the top boundary of the Żyrzyn and Sochaczew beds is of erosional origin, generally displaying stratigraphical hiatus of varying extent. In extreme case, at Bochotnica and Nasiłów the erosion corresponding to this hiatus reached deeper strata than usual and destroyed nearly complete series of Żyrzyn beds ending activity at the hard ground surface which corresponds to the hard limestone layer in the bottom of the Żyrzyn beds at Żyrzyn and Góra Puławska, thus proving that deposits resting directly on a hard ground surface may differ in age. So the hard ground layer at Pamiętowo is of a different age from that at Bochotnica, Góra Puławska or Żyrzyn. It is formed there on older Maastrichtian horizons, probably Lower Maastrichtian. The Żyrzyn beds are never exposed being a typical subsurface formation. They still belong to the Upper Maastrichtian and probably represent the highest Upper Maastrichtian horizon. In their greatly increased glauconite content and marked decrease in calciferous they differ very distinctly from the underlying Upper Maastrichtian »opoka« beds. They are separated from the latter by a hard ground layer which is absent only at Sochaczew where, in spite of this, the lithological boundary is very sharp.

SOCHACZEW BEDS — DANIAN

(Text-plates III-IV)

The Sochaczew beds overlie the Żyrzyn beds. They are 5·5 m. thick at Góra Puławska, 4 m. — at Żyrzyn, and 6 m. — at Sochaczew. In lithology they approach the Żyrzyn beds from which they differ distinctly only at Góra Puławska, being represented there by a series of marls with an admixture of pyrite. The characteristic feature of the Sochaczew beds is that in all the three borings here the initial phase of sedimentation is associated with an increased supply of terrigenous material and with a stronger glauconite content. Therefore this might even suggest a somewhat transgressive character of this stage. Higher up however in the section there is a decrease in the number and size of the quartz and glauconite grains in the sediment, equalling



CORRELATION OF ŻYRZYN AND BOCHOTNICA SECTIONS IN CENTRAL POLAND

those in the Żyrzyn beds. The lower part of the local »z« horizon (POŻARYSKI, 1938) is of the same age as the Żyrzyn and Sochaczew beds at Bochotnica and Nasiłów, south of Puławy (Text-plate IV), and probably also as throughout the southern part of the Lublin region. This »z« horizon is a phosphate layer occurring on the indurated surface of the hard ground. A typical feature of this layer is the abundance of reworked Upper Cretaceous fauna, chiefly *Belemnella casimirovensis* and *Pecten acuteplicatus*, in association with Danian foraminifers. Thus the Danian here occurs as relict deposits, indeed, in this form it may be encountered in a considerable area of the Lublin region, from the middle course of the river Wieprz in the east as far as the Vistula in the west. Also the Danian deposits in Belgium and southern Netherlands (Limburg-Vroenhoven) have an analogous condensed character.

The Danian age of the Sochaczew beds must be more exactly proved because of the lack of index forms. The proof may be based on the following: 1° the boundary between Żyrzyn and Sochaczew beds corresponds to that between Maastrichtian-Danian, 2° the boundary between Sochaczew and Puławy beds corresponds to that between Danian-Paleocene. The former is the boundary in which over 80 foraminiferal species characteristic for Maastrichtian have disappeared, and a new assemblage characteristic for Danian and Paleocene appears. The latter is characterized by the appearance of about 20 index species for the Lower Paleocene (Selandian) of Sweden, Denmark and Crimea.

PUŁAWY BEDS — LOWER PALEOCENE (MONTIAN)

The Puławy beds are 40 m. thick at Góra Puławska and Żyrzyn, 54 m. — at Sochaczew and 33·5 m. — at Pamiętowo. At Góra Puławska and Żyrzyn they are represented by calcareous gaizes with marly-limestone intercalations, at Sochaczew by glauconite sands with sandstones, while at Pamiętowo by detritic limestones resembling the typical »tuffeau« known from Belgium and southern Netherlands.

On the whole, the Puławy beds are characterized by a considerably greater quartz and glauconite content than in the lower beds of Sochaczew and Żyrzyn. At Sochaczew the quartz content amounts to 30-40%, glauconite to approx. 10%. At Żyrzyn the quartz content is much lower being only 8%, at Góra Puławska 10%, while that of glauconite is 5% and 4% respectively. Similarly as in the beds of Sochaczew and Żyrzyn, sedimentation of the Puławy beds begins with a marked increase in the size of the quartz and glauconite grains, the latter being macroscopically indicated. Hence it is reasonable to infer the transgressive character of the Paleocene here (Text-plate V).

CONCLUSIONS

(Text-plates II—V; Table 3)

A study of the data available so far from the three regions under discussion indicates a striking lack of uniformity in the development of the Danian and Lower Paleocene deposits. On the whole it may be assumed that at the boundary of the Maastrichtian and the Paleocene this series in the Polish Lowland is extremely condensed. This reduction in sediment began during the Upper Maastrichtian being expressed by the formation of an indurated hard ground layer, a sedimentary hiatus and changes in the nature of the sediment. The limestone hard

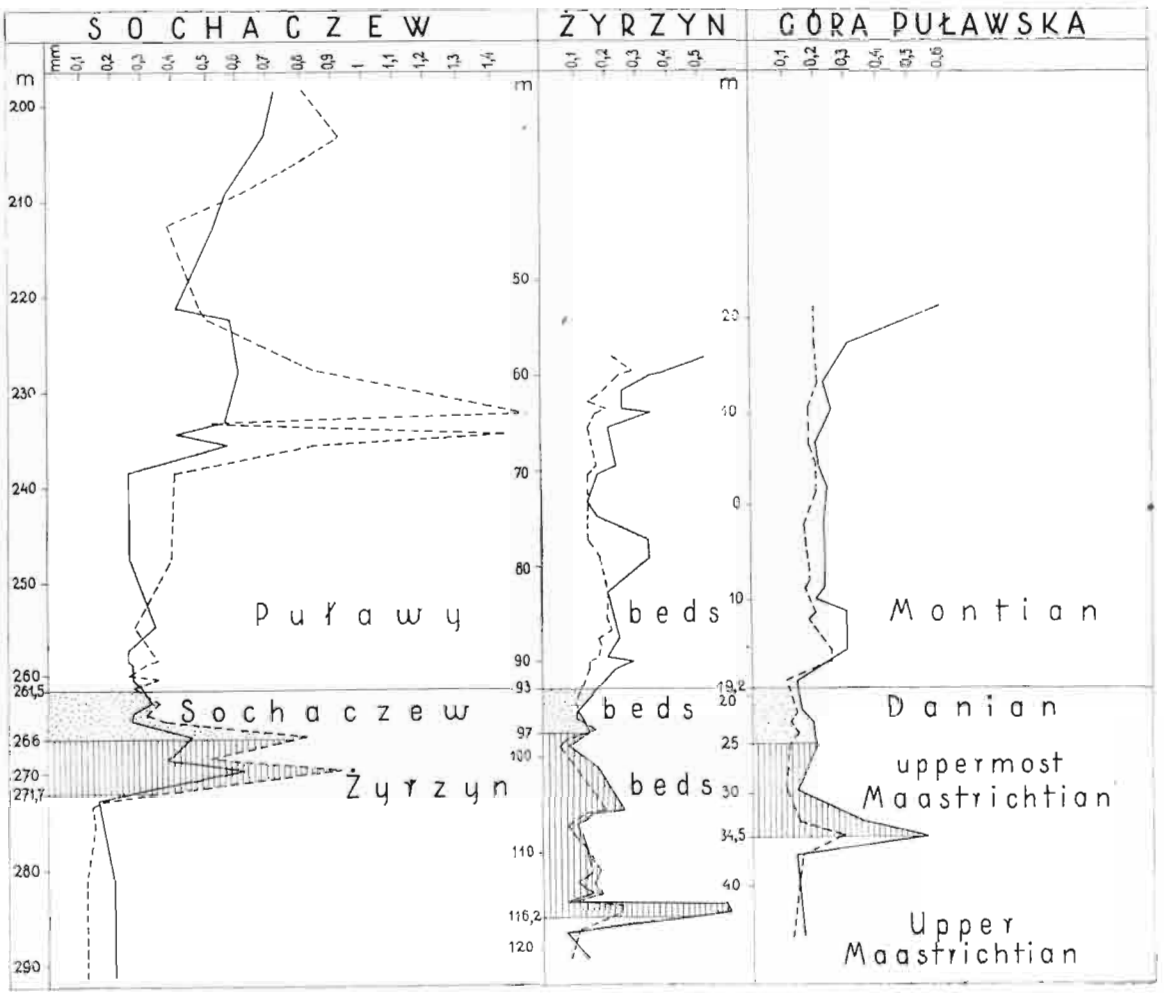
ground layer varies in age in different parts of the area. The sedimentary hiatus with which it is connected approximately corresponds with the Upper Maastrichtian, while in the vicinity of Puławy, Żyrzyn, Góra Puławska, Bochotnica and Nasiłów the limestone hard ground layer is of the same age and has been referred to the local »y« horizon (POŻARYSKI, 1938), containing *Belemnella casimirovensis*. In borings at Góra Puławska and Żyrzyn the hard ground layer does not terminate the Upper Maastrichtian sedimentation. Macro- and microfaunal investigations indicate that the sedimentary series called the Żyrzyn beds, resting in the above named borings on a hard ground of indurated limestone, represent the *Belemnella casimirovensis* horizon of the uppermost Maastrichtian (possibly the *Pseudotextularia* zone — though the index form has not been found there). In the vicinity of Bochotnica these layers have probably been completely denuded since in the glauconite beds in the hard ground canals contain a Danian microfauna with *Globigerina daubjergensis*.

Subsequently the Sochaczew beds were laid down by the Danian transgression. Locally they occur as remnants, similarly as in the Żyrzyn beds. An analogous situation occurs at Pamiętowo as well as in Bochotnica and Nasiłów where the Danian deposits are represented by a very thin layer. In the vicinity of Bochotnica and Nasiłów, Maastrichtian fossil remains such as *Belemnella casimirovensis*, *Pecten acuteplicatus* et al. have been introduced into the Danian deposits as a result of the abrasive outwashing of the Żyrzyn beds. Of some interest is the phosphate-bearing glauconite layer with abundant remains of *Belemnella casimirovensis*, reached in the Żyrzyn boring and encountered in exposures at Bochotnica and Nasiłów. Its age is not contemporaneous with that of a layer at Góra Puławska whose lithology is very similar and from which it differs only in a higher marl content. The Żyrzyn rocks are phosphate-bearing glauconite marls, those at Bochotnica slightly calcareous phosphate-bearing glauconite sandstones. At Góra Puławska, similarly as at Żyrzyn, the above named layer is overlain by a series of uppermost Maastrichtian deposits known as the Żyrzyn beds. These are absent from Nasiłów and Bochotnica where, on strongly condensed remnants of the Sochaczew beds, they rest directly on the rocks of a »siwak« series, i.e. the Puławy beds representing the Lower Paleocene stage.

The development of the Sochaczew beds is rather varied. Locally they rest on the Żyrzyn beds, that are either partly eroded, being only half as thick as those at Żyrzyn, or completely eroded as at Bochotnica and Nasiłów. Hence the deposition of these strata was probably preceded by erosion which locally completely destroyed the Żyrzyn beds. At Góra Puławska the deposits consist mainly of grey dark marls, rich in pyrite but poor in glauconite, at Żyrzyn they are the grey »opoka« interbedded with hard marls. The latter are absent from Bochotnica and Nasiłów. Their age equivalent is that of the phosphate-bearing glauconite sandstone layer (local »z« horizon of POŻARYSKI, 1938) with redeposited Upper Maastrichtian fauna. This layer was secondarily enriched as a result of the erosion of the Żyrzyn beds which, as in the Żyrzyn boring, are crowded with the rostra of belemnites and shells of pectenids. Until quite recently the secondary position of the belemnite-bearing strata was in doubt in view of the sporadic occurrence of belemnites in the underlying »opoka« layer. Lately, however, the matter has been clarified. They abound not so much in sediments of the »opoka« as in the overlying Żyrzyn bed. Where the latter have been eroded, as at Bochotnica and Nasiłów, a great assemblage of belemnites is found together with deposits of the Sochaczew beds — of Danian age — sometimes, due to complete erosion of the Danian beds, even found together with those of the Puławy beds, currently known as the »siwak« rocks.

The fullest development of the Sochaczew beds occurs at Sochaczew. Here they are represented by a series of glauconite sandstones, intercalated by sandstones bearing a Danian

TEXT-PLATE V



DIAGRAMMATIC CORRELATION OF THE SIZE OF QUARTZ AND GLAUCONITE GRAINS IN BORINGS

On the vertical axis the depth of the borings in Sochaczew, Żyrzyn and Góra Puławska is given. In Góra Puławska the boring was located on the bottom (0) of a quarry, so the depth there is calculated above 0 m. height on the wall of the quarry, as well as below. The dotted area refers to the Danian (Sochaczew beds), the striped — to the Żyrzyn beds, uppermost Maastrichtian. Samples further down coming from Upper Maastrichtian, while those above the dotted area — from the Lower Paleocene (Montian or Selandian).

TABLE 1

ASSEMBLAGE OF FORAMINIFERA RECORDED IN THE UPPERMOST MAASTRICHTIAN, DANIAN AND MONTIAN SEDIMENTS IN POLAND

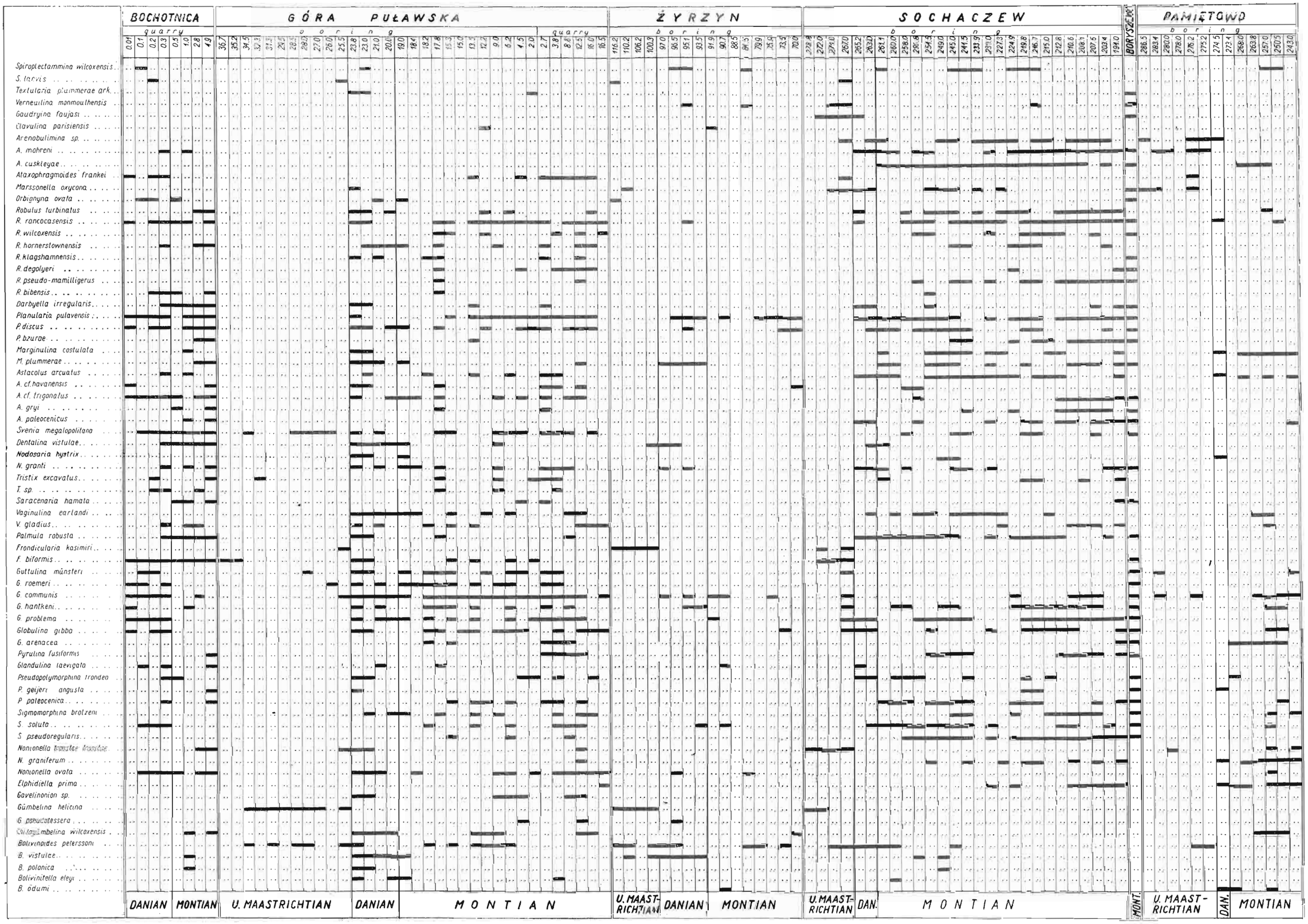
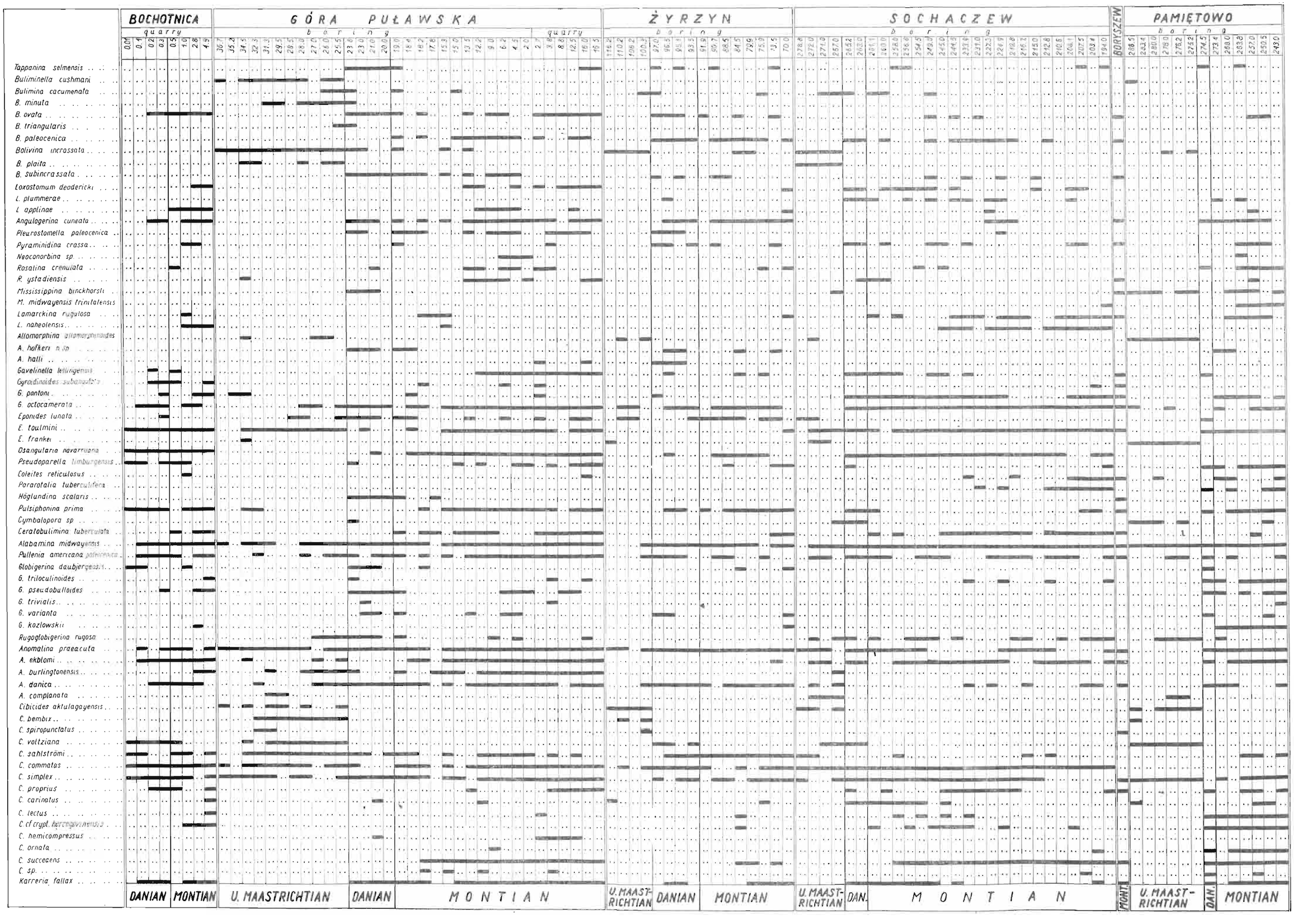


TABLE 2

ASSEMBLAGE OF FORAMINIFERA RECORDED IN THE UPPERMOST MAASTRICHTIAN, DANIAN AND MONTIAN SEDIMENTS IN POLAND



microfauna. Practically speaking the »Sochaczew beds« are lacking at Pamiętowo. We are dealing with the beds equivalent of the local »z« zone of Bochotnica which is represented by the outwashed Żyrzyn beds and condensed Sochaczew beds.

In contrast to the above mentioned beds, i.e. Żyrzyn and Sochaczew beds, Puławy or »siwak« beds are encountered in the margin of the middle Vistula valley near Kazimierz and Puławy, where they have long been known under the name of the »siwak«. Over large areas they are uniformly developed as a series of grey-greenish limestone »gaizes«, rhythmically interbedded with stratified limestone. They are the exact age equivalent of the Lower Paleocene (Montian or Selandian). The Puławy beds are the most developed having the widest distribution, and are represented in all the borings under consideration, while the above described Sochaczew and Żyrzyn beds are known only from borings and do not outcrop, therefore, they are typical subsurface formations.

On the diagrammatic correlation the base of the Żyrzyn beds is characterized by an increase in quartz and glauconite grains (Text-plate V). Moreover the character of the sediment of the Żyrzyn beds does not differ from that of the Sochaczew beds which in general is marly, containing a greater or less admixture of quartz and glauconite.

The Lower Paleocene sedimentation also did not change its general character with the exception of that in the areas of Żyrzyn and Góra Puławska, where an increase in the size and amount of quartz and glauconite grains can be noted.

ANALYSIS OF MICROFAUNA

(Text-plate VI; Tables 1, 2)

A collection of 142 species, found in the sediments of the uppermost Maastrichtian, Danian and Lower Paleocene of the Polish Lowland is presented in Tables 1 and 2. This material covers data obtained from 5 borings, at Góra Puławska, Żyrzyn, Sochaczew, Boryszew and Pamiętowo, as well as from outcrops at Bochotnica. Data obtained from the boring at Magnuszew have not been taken into account since no Danian sediments were recorded in that boring. For the sake of simplification, the Lower Paleocene sediments have been called the Montian although their strict correspondence to the Montian of the type locality, that is the »Calcaire de Mons« in the Mons Basin has not yet been proved. The most important species of foraminifers, characteristic of the boundary between these horizons, are given in Text-plate VI.

Only a dozen or so of the more characteristic species identified have been used to describe the Upper Maastrichtian layers which, in the present work, were not a subject of particular interest. It is clear from this list of species that their extent is limited to the uppermost Maastrichtian and that they do not exceed the upper limit of the Żyrzyn layers. As long as our knowledge of this problem was based exclusively on the outcropping sections, mostly at Kazimierz and Bochotnica, the boundary between the Maastrichtian and Danian was interpreted in Poland as a lithological boundary. Now, when boring sections are available reaching down to deeper parts of the sedimentary basin, it is clear that the upper limit of the Maastrichtian in the borings at Góra Puławska, Żyrzyn and Sochaczew does not make up any clearly outlined lithological boundary. On the boundary of the »Żyrzyn beds« (Upper Maastrichtian), which are already represented not by the white »opoka« rocks but by glauconite marls, and the »Sochaczew beds« (Danian), similarly represented, not only the extinction of great numbers of foraminiferal species (over 80) can be recorded, but also the appearance of a new assemblage of 72 species. In the

latter assemblage, there are 28 species common to the Danian of Sweden and Denmark where they also have never been recorded below the Danian beds. This applies to the following species: *Spiroplectammina wilcoxensis*, *Robulus rancocasensis*, *R. turbinatus*, *Planularia discus*, *P. pulavensis*, *Astacolus paleocenicus*, *Vaginulina gladius*, *Glandulina laevigata*, *Pseudopolymorphina geijeri*, *Sigmomorphina soluta*, *Nonion graniferum*, *Nonionella ovata*, *Elphidiella prima*, *Chiloguembelina wilcoxensis*, *Tappanina selmensis*, *Bulimina paleocenica*, *Angulogerina cuneata*, *Pyramidina crassa*, *Pleurostomella paleocenica*, *Rosalina ystadiensis*, *Allomorphina halli*, *A. hofkeri* n. sp., *Globigerina daubjergensis*, *G. triloculinoides*, *G. pseudobulloides*, *G. varianta*, *Cibicides proprius*, *Karreria fallax* f. *typica*, *Loxostomum* cf. *plummerae*.

The Polish Danian (Sochaczew beds) occurs in a facies which generally does not differ from that of the lowermost Paleocene (»Puławy beds«), called in Poland, the Montian. New fauna, appearing in the Polish Danian is relatively poor as compared to that of the Upper Maastrichtian. This concerns both the macro- and microfauna. No index foraminifers, characteristic exclusively of the Danian, have been found so far either in Poland or in the type region (Denmark, Sweden). No index fossils for Danian were recorded in U. S. S. R. (BYKOVA, 1960). The pelagic foraminiferal assemblage, together with *Globigerina daubjergensis*, cited by many authors, is completely different from that of the Upper Maastrichtian and is not confined to the Danian only, but passes to the Lower Paleocene (the Montian). This is a phenomenon already fairly well-known and the writer's observations in Poland fully support this view. Moreover, this applies virtually to the entire assemblage of foraminifers both pelagic and benthonic. At the beginning of the Montian, a dozen or so new species appear which so far were unknown in the Danian. Thus, the assemblage of the Danian foraminifers differs only slightly although quite distinctly, from that recorded in the Montian. This difference consists in the absence in Danian of the following species appearing only in Montian: *Arenobulimina cuskleyae*, *Robulus degolyeri*, *R. pseudo-mamilligerus*, *R. wilcoxensis*, *Astacolus gryi*, *Saracenaria hamata*, *Planularia bzurae*, *Pyrulina fusiformis*, *Loxostomum applinae*, *Lamarckina naheolensis*, *L. rugulosa*, *Ceratobulimina tuberculata*, *Mississippina midwayensis trinitatensis*, *Globigerina (Subbotina) kozlowskii*, *Cibicides mammillatus*, *C. succedens*, *C. lectus*, *C.* cf. *cryptomphalus hercegovinensis*, *Sigmomorphina pseudoregularis*.

The boundary between the Danian and the Montian in Poland is, therefore, determined not on the basis of the extinction of certain forms, but only and exclusively on the basis of the appearance of new species. The Danian in Poland is, therefore, separated from the Montian according to evidence negative in character. Under such circumstances, the question arises whether this evidence is sufficient for the distinction of these stages in Poland? Poland is a region not alone in this respect since a similar situation can be met with as a rule everywhere and there is no country, Denmark and Sweden included, in which an assemblage of foraminifers could occur characteristic only for the Danian. This is probably the reason why the Danian and the Paleocene were repeatedly combined into one stratigraphical concept and given by various authors the working name of »Dano-Paleocene«, and why in the United States the Danian was included into the Paleocene as its lower part (LOEBLICH & TAPPAN, 1957b, c; LOEBLICH, 1958).

The distinction of the Danian in Poland is based, therefore, on the observations:

1) that the assemblage of typically Paleocene foraminifers occurs at a certain distance above the boundary of the extinction of the typically Maastrichtian foraminifers and the appearance of an assemblage approaching in character the Paleocene and,

2) that, except in certain instances of distinct sedimentary hiatuses, it never contacts the Maastrichtian assemblage. Thus distinguished, the Danian should perhaps correspond to a unit

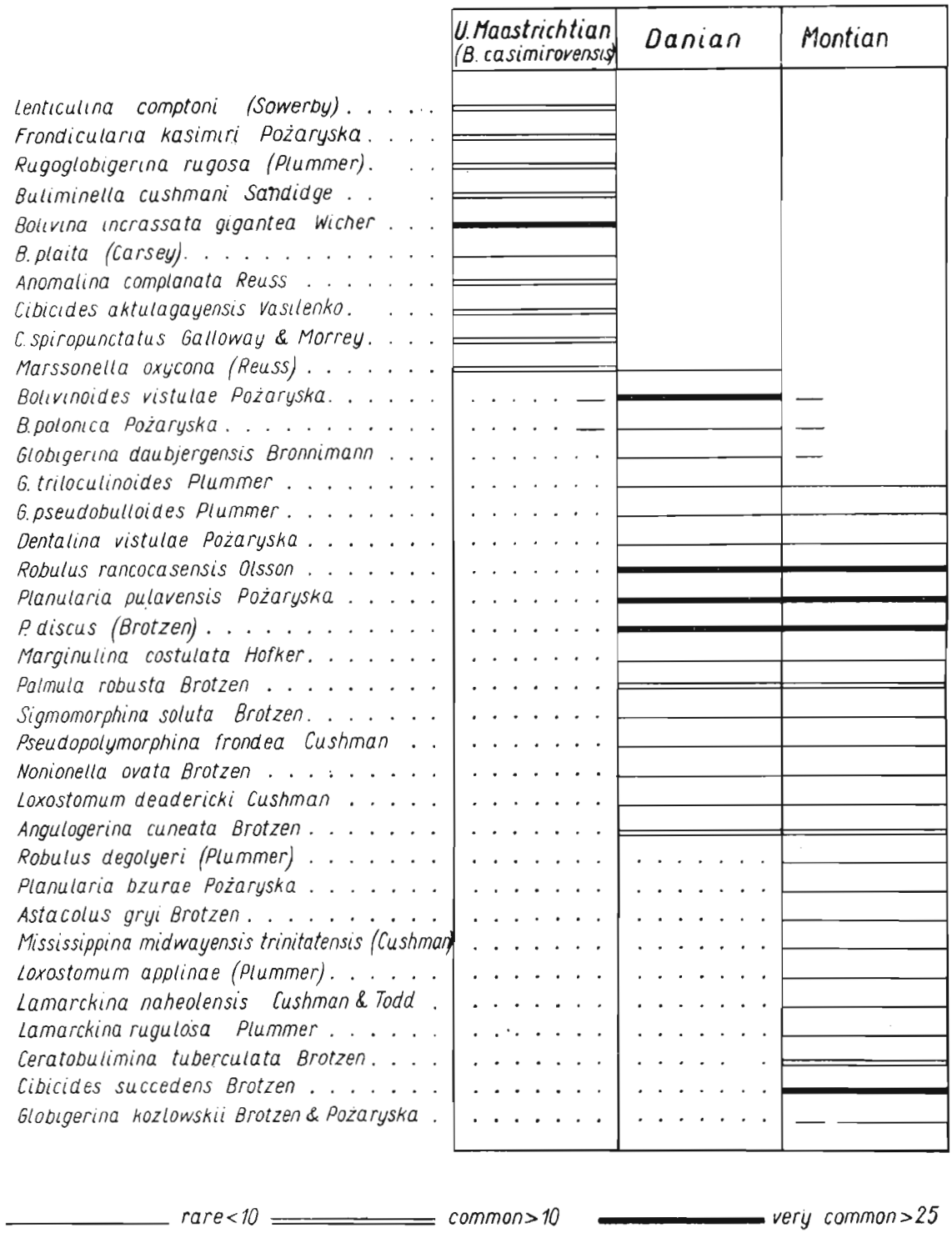
TABLE 3

LITHOLOGY AND STRATIGRAPHY OF STUDIED SECTIONS IN POLISH LOWLAND (GÓRA PUŁAWSKA, BOCHOTNICA, NASIŁÓW, ŻYRZYN, SOCHACZEW, PAMIĘTOWO)
DIAGRAMMATIC CORRELATION

Stage		Index fossils	Horizons (Pożaryski, 1938; Pożaryska, present paper)	GÓRA PUŁAWSKA boring and quarry			BOCHOTNICA and NASIŁÓW quarries		ŻYRZYN boring			SOCHACZEW boring			PAMIĘTOWO boring		
				lithology	depth in m.	thickness in m.	lithology	thickness in m.	lithology	depth in m.	thickness in m.	lithology	depth in m.	thickness in m.	lithology	depth in m.	thickness in m.
TERTIARY	MONTIAN or LOWER SELANDIAN	*Ceratobulimina tuberculata* Brotzen *Lamarckina rugulosa* Plummer *Loxostomum applinae* Plummer	PUŁAWY BEDS (so-called »siwak«)	Calcareous gaize, thin intercalations of limestone		40·0	Calcareous gaize, intercalations of limestone Glauconitic sand, pectens, belemnites (derived) and phosphatic nodules	20·0	Calcareous gaize, intercalations of marl		40·3	Glauconitic sand, intercalations sandstones		54·0	Detritic sandy limestone (type tuffeau), intercalations of compact limestone		33·5
				*)	19·5					93·0			247·5			273·5	
	DANIAN	*Globigerina daubjergensis* Bronnimann *G. pseudobulloides* Plummer *G. triloculinoides* Plummer	SOCHACZEW BEDS	Gray marl, small concretions of pyryte		5·5	Remnants Glauconitic sand with belemnites (derived) and phosphatic nodules	0·2—0·3	Gray »opoka«, intercalations of hard marl		4·0	Glauconitic sand, intercalations of sandstones		6·0	Sand with phosphatic nodules		1·0
					25·0					97·0			6·0			274·5	
CRETACEOUS	MAASTRICHTIAN UPPERMOST	*Belemnella casimirovensis* Skołozdro *Sphenodiscus binckhorsti* Böhm *Bolivina incrassata* Reuss *Rugoglobigerina rugosa* (Plummer)	ŻYRZYN BEDS	Calcareous gaize, intercalations of marl		9·5	Żyrzyn beds missing	19·5	Gray »opoka«, intercalations of hard marl		19·7	Sand with marls, intercalations of sandstone		5·7	Żyrzyn beds missing		
	UPPER		layer »z«	Glauconitic sand with phosphatic nodules	34·5				Glauconitic marl, phosphatic nodules	116·5		Sand with belemnites, phosphatic nodules	217·7				
			layer »y«	Hard ground			Hard ground		Hard ground						Hard ground		
			layer »x«	White »opoka« (siliceous limestone)			White »opoka« (siliceous limestone)		White »opoka«, (siliceous limestone)			White »opoka« (siliceous limestone)			Gray detritic limestone		

*) ——— = unconformity or hiatus.

TEXT-PLATE VI



INDEX SPECIES OF FORAMINIFERA IN UPPER MAASTRICHTIAN, DANIAN AND MONTIAN OF POLAND

of a horizon or a sub-horizon, and not a geological stage, the more so as the Danian layers are not as a rule of any considerable thickness.

One more difficulty, quite different in character, is met in distinguishing the Danian. This is a taxonomic difficulty. Many species which do not differ from each other to any significant extent, have already been described under various names. In the present paper, they are considered as not related to each other. Further investigation is, however, necessary to decide whether they are really separate species, as they have been described, or whether they represent only certain stages of development during their Maastrichtian — Danian-Paleocene evolution. The differences between them, if they exist at all, are in general quite small and insignificant. In some cases, such differences could be successfully explained by intraspecific variability.

DANIAN AND SELANDIAN IN THE TYPE REGION OF DENMARK AND SWEDEN

(Text-plate IX; Table 4)

The Danian stage was determined and defined by DESOR in 1846. The Calcaire pisolithique exposures in the Paris Basin and the shore outcrops in the eastern part of Zealand, stretching south of Copenhagen along a belt well over 10 km. in length, were used by this author as the index sections of that stage. They are currently known as the Stevns Klint profiles. The Danian there comprises chiefly white-greyish, not very hard, coccolithic-bryozoan limestones, with numerous dark grey to black flints, which form more or less horizontal strata. All that rock series rests unconformly on Upper Maastrichtian White Chalk beds, called by BROTZEN (1945) the Stevnsian beds, after Stevns Klint. The rock series distinguished by DESOR (1846) is regarded still by some Danish and Swedish authors as the youngest horizon of the Cretaceous system, according to the original DESOR'S opinion and definition. But already FORCHHAMMER (1823), BRÜNNICH NIELSEN (1919), and latest ROSENKRANTZ (1924, 1960) consider the strata as representing the lowermost Tertiary.

The Stevns Klint shore section, however, comprises only the lowest part of the Danian deposits. Its higher horizons occur near-by at Fakse. Together with the Danian sediments, well exposed at Limhamn in Sweden, they are, according to TROELSEN'S (1956) and BROTZEN'S (1956) opinions, the so-called type region. In Denmark they were studied and described in several papers by RAVN, BRÜNNICH NIELSEN, LEVINSEN, ROSENKRANTZ, ØDUM, WIENBERG RASMUSSEN, BERTHELSEN and others in this century.

At Fakse, in a large quarry, coral limestones are found slightly younger than those at Stevns Klint, occurring as more or less regular banks alternating with the bryozoan and fine pelitic limestones. A complete Danian profile section outcrops in Scania, in southern Sweden. There the facial development and the stratigraphy may be traced in the 80 m. high wall of a huge quarry, belonging to the Limhamn Cement Works (near Malmö), which has been thoroughly investigated by BROTZEN (1959). The zonation of the Danian into 4 stratigraphical horizons is based on echinid spines of the genus *Tylocidaris*, proposed by ROSENKRANTZ (1937); they are rather abundant in most of the Danian deposits in Denmark as well as in Sweden.

The Danian deposits of the type region attain a considerable thickness: up to 80 m. in Sweden, and 200 m. in Denmark. They are deposited in a depression which BROTZEN (1959) calls the Danish-Swedish syncline, and POŻARYSKI (1957) — the Danish-Polish furrow or geosyncline, more recently known as the Danish-Polish parageosyncline. Farther to the south-east within this basin Danian sediments were deposited in Poland.

DANIAN IN DENMARK

(Text-plates VII, IX)

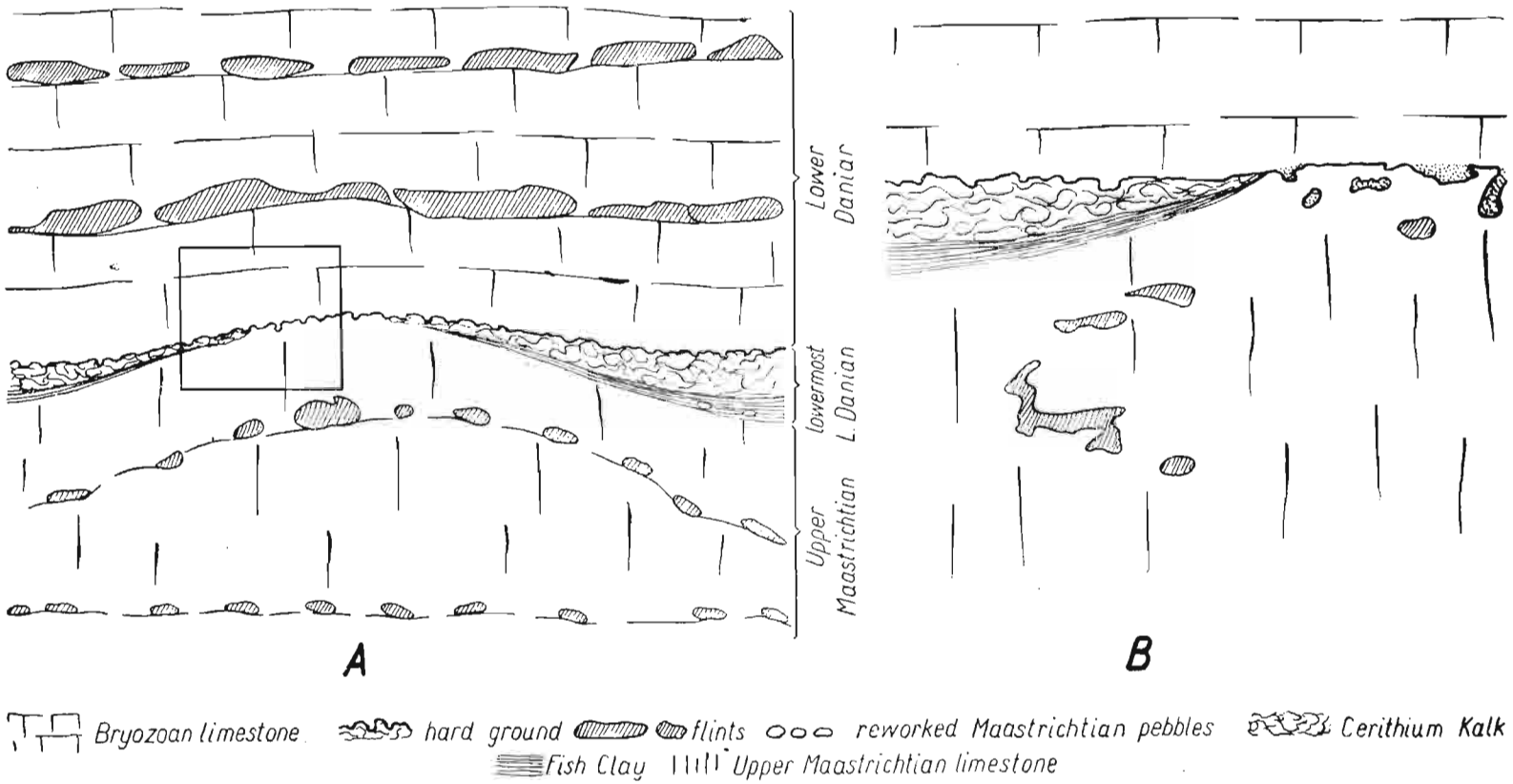
In Denmark, at Stevns Klint, the highest horizons of the Upper Maastrichtian (Stevnsian) are characterized by the presence of *Scaphites (Hoploscaphites) constrictus* SOW., *Belemnella casimirovensis* SKOŁ., *Belemnitella junior* NOW. (BIRKELUND, 1957) and of spines of *Tylocidaris baltica* SCHLÜTER. They are developed as white chalk in the highest uppermost horizons, passing into bryozoan chalk which is sharply delimited from the white chalk and still contain an important admixture of pelitic Cretaceous material. In places, where the bryozoans accumulated in greater abundance, the material was laid down more rapidly at the bottom resulting in the formation of domed elevations at the sea floor. This is shown by the position of the uppermost chert layers of the Maastrichtian, which do not occur horizontally, but rise as domes above the bryozoan accumulations (Text-plate VII).

In the depressions of the undulating chalk surface, thin dark stratified marly clays with small chalk pebbles, some centimetres thick, are to be found. This layer, known as the »Fiskeler« (English—Fish Clay), consisting of montmorillonite and supposed by ROSENKRANTZ (1955) to be a disintegrated tuff (ash) layer, does not, as a rule, occur on Cretaceous hummocks. It is overlain by a layer of light-yellow, brecciated limestone, the so-called »Cerithium Kalk« — Cerithium limestone, up to 1 m. thick. The upper part of the »Cerithium Kalk« layer belongs to a hard ground, also comprising the uppermost part of the Senonian bryozoan chalk, and is a secondarily indurated limestone. The outwash surface, corresponding to the hard ground, completely truncates these layers on the chalk hummocks, while the »Fiskeler« horizon did not originally occur on the hummocks. In places, where the »Cerithium Kalk« was eroded, hard ground formed directly on the chalk which was slightly endurated down to a depth of ca. 20 cm. This surface is uneven, corroded, cut up by numerous depressions that form characteristic peculiar depressions pockets, and burrows often reaching down as far as 0·5 m. below the surface of the hard ground. Silicified sponges whose presence, according to ROSENKRANTZ (1960), may be associated with the formation of the »pockets«, are often embedded in these depressions. The original thickness of the »Cerithium Kalk« was probably much greater. The Cerithium limestone contains a typical Danian macrofauna (ROSENKRANTZ, 1924b, 1939), whereas the »Fish Clay«, according to the same author, contains lumps of white chalk and a lot of reworked Upper Maastrichtian macrofossils, especially echinids, bryozoans and some fragments of baculites.

On the »Cerithium Kalk« layer or, when this is absent, directly on Upper Maastrichtian sediments, bryozoan limestones of the lower Danian are to be found. They are grey-white, rather hard, pure limestones, with numerous black flints, occurring rhythmically at more or less regular intervals. The limestones here form a kind of low, widely radiating reef structures, consisting mainly of bryozoans. These are biostromes. At certain time-intervals due to intermittent facial changes, beds of flint probably formed in the not yet consolidated sediment, adjusting to the irregularities of the bottom. Some biostromes, of a younger age, overlapping the older bioherms, are very distinctly registered by the discordant arrangement of the flint layers. The occurrence of the hard ground, either associated or not with outwashing, is locally well indicated, where the older bioherm meets the younger one. The development of these surfaces greatly varies, sometimes the bifurcation of the indurated surfaces is very marked, but it is a local phenomenon. In fossil hard ground the carapaces of *Dromiopsis rugosa* often are to be found in the depressions of the corroded surface. This was observed by ROSENKRANTZ at Fakse.

In the Danian deposits of the shore outcrops of Stevns Klint spines of the regular echinid *Tylocidaris* are absent in the Cerithium limestone, but in the lowermost part of the bryozoan

TEXT-PLATE VII



SCHEMATIC DIAGRAM OF A PART OF UPPER MAASTRICHTIAN-DANIAN BEDS

A at Stevns Klint near Højerup, Zealand in eastern Denmark, *B* enlarged section of a portion of *A*

limestone *Tylocidaris oedumi* is fairly abundant. In the uppermost part *T. abildgaardi* — the index fossil of the uppermost Lower Danian — occurs in great numbers.

Exposures in the neighbouring locality of Fakse (Faxe) complete the Danian profile at Stevns Klint. Danian horizons, higher than those of Stevns Klint (i.e. of Middle Danian age), outcrop at Fakse in an old quarry of bryozoan limestones, occurring as extensive bioherms, and coral (reef) limestones are to be found irregularly interbedded there. Distinct detailed undulating stratification of the bryozoan limestones can be observed thanks to the presence of beds of black flint, that are totally absent in the coral reef limestones. The numerous coral species and the macrofaunal assemblage accompanying coral reefs has been described by BRÜNNICH NIELSEN, RAVN, WIENBERG RASMUSSEN, BERTHELSEN and others. The bryozoan limestones are hard, locally dolomitized with the fossil shells (aragonite), completely dissolved.

Upper Danian rocks outcrop in the vicinity of Copenhagen and on the Jutland peninsula. The best accessible exposures occur at Mønsted and Hvalløse in northern Jutland. Moreover limestones of the Upper Danian are fairly often encountered in hard, glacial boulders, called »Saltholm limestone«. The Upper Danian is represented by pelitic coccolithic limestones, of varying degree of hardness, which in Jutland occur in the overlying cover of its Zechstein salt domes. In east Zealand, where no salt domes occur, the hardening of these limestones are still more pronounced. Upper Danian limestones contain numerous thick beds of grey flints. The macrofauna in the limestones of the Upper Danian is, as a rule, extremely poor, while the microfauna is very abundant. The uppermost part of this series contain in east Zealand abundant macrofossils. At Hvalløse, just above the Upper Danian limestones, Lower Paleocene deposits are exposed, the latter represented by glauconitic conglomerate with pebbles from the underlying limestones, and occasionally with outwashed Danian fossils. Green glauconitic marls rest on the conglomerates. A similar sequence has been described from east Zealand.

Thus it is seen that in the island of Zealand and northern Jutland a rather complete sedimentation at the boundary of the Cretaceous and the Tertiary can be supposed. A major stratigraphic hiatus seems to exist between the Maastrichtian and the Danian in this area. In the south of Denmark, in southern Jutland and in the islands the relation of the Danian and the Paleocene to the Maastrichtian becomes more complicated. These conditions were vividly expressed by ROSENKRANTZ at the International Congress of Geology at Copenhagen (1960) in the following statement: »At Gedser, the southernmost tip of Denmark, the Danian is totally absent, the Selandian directly resting on the Maastrichtian. In the southernmost Danian localities extending from Laaland to southern Jutland the Upper Danian strata rest on the Maastrichtian. This means that the Danian sea in late Danian time transgressed from the North«.

Table 5 shows the stratigraphy of these strata in Denmark. The uppermost Danian, i.e. the *Tylocidaris vexillifera* horizon, is absent in the type localities (Stevns and Fakse). The data are adapted from TROELSEN (1957), which is in accordance with the view expressed on former occasions by ROSENKRANTZ (1937).

In the Danian deposits of Denmark *Hercoglossa danica* (SCHLOTHEIM) is known from the Middle Danian, and *Crania tuberculata* (NILS.) — from the uppermost horizon of this stage. Samples of bryozoan and coccolithic limestones of the Danian from Stevns Klint yield relatively small numbers of foraminifers. The microfauna there is as yet inadequately investigated. It has been recently studied by the following authors: BROTZEN (1940, 1945, 1948), TROELSEN (1957), BRONNIMANN (1952), REICHEL (1953), but they were, however, interested rather in planktonic foraminifers. The more detailed investigation of TROELSEN *(l. c.)* recorded the presence of globigerines in great abundance, mainly in the bottom of the *Tylocidaris oedumi* and *T. vexillifera* horizons. In the remaining horizons globigerines are rather scarce. Thus, according to

TROELSEN, there occur in the *T. oedumi* horizon of the lowermost Danian great numbers of *Globigerina pseudobulloides* and detached specimens of *G. daubjergensis*. In the higher *T. abildgaardi* horizon, *G. pseudobulloides* is considerably less numerous, while there is an increase of the number of *G. daubjergensis*. In the *T. bruennichi* horizon, the next above, these proportions are still more pronounced, but in the *T. vexillifera* horizon of the uppermost Danian the situation is just the reverse, there *G. pseudobulloides* is present in extremely small numbers, while representatives of *G. daubjergensis* occur in great abundance.

Other globigerine species, common in the Danian, are present in Denmark in the higher strata of this stage. Thus, *Globigerina triloculinoides* appears in the *Tylocidaris bruennichi* horizon and is fairly abundant in the uppermost Danian, while *G. compressa* occurs in the highest *T. vexillifera* horizon.

According to BERGGREN (1962*b*), the following groups of planktonic foraminifers disappear in Scandinavia at the boundary of the Upper Maastrichtian chalk: *Globotruncana* s. str., *G. (Rugotruncana)*, *Heterohelix*, *Planomalina (Globigerinelloides)*, *Praeglobotruncana* s. str., *P. (Hedbergella)*, *Pseudotextularia* and *Rugoglobigerina*. They are replaced by *Globigerina*, *Globorotalia (Turborotalia)* and *Chiloguembelina*. Thus the fauna of planktonic foraminifers characterizing the Upper Maastrichtian (Stevnsian) is replaced by an assemblage of minute globigerines. These small primitive forms of the Lower Danian were subsequently differentiated in the higher strata of this stage. During the Paleocene of Scandinavia, the so-called Selandian, they are again extremely rare.

In addition to the planktonic foraminifers, mentioned above by TROELSEN, the following forms were found, distinguished by HOFKER (1960*b*) in a sample from the Cerithium Kalk of Stevns Klint: *Globigerina* cf. *quadrata* WHITE, *G.* cf. *linaperta* FINLAY, *G. supracretacea* HOFKER, *Guembelina wilcoxensis* (CUSHMAN & PONTON), *G. globulosa* (REUSS) and *Guembelitria mauriciana* COLE.

The benthonic forms there are poor. A few species only were found by HOFKER: *Tritaxia danica* HOFKER, *Nodosarella paleocenica* CUSHMAN & TOOD and *Allomorphina paleocenica* CUSHMAN.

The present writer, however, ascertained the presence of the following species in a sample collected from the Cerithium Kalk: *Karreria fallax* RZEHAK, *Osangularia lens* (BROTZEN) (=*O. cordieriana navarroana* CUSHMAN), *Pulsiphonina prima* (PLUMMER), *Gavelinella pertusa* MARSSON, *Robulus rancocasensis* OLSSON, *Cibicides proprius* BROTZEN, *C. simplex* BROTZEN, *C. bembix* MARSSON, *Anomalina acuta* (PLUMMER) and *A. danica* BROTZEN.

Of the above named species only *Cibicides simplex* was occurring in great abundance, while the other forms were present only as isolated specimens.

A markedly richer foraminiferal assemblage was identified by the present writer in a sample, collected with generous help of Professor A. ROSENKRANTZ, in 1960 from the Bryozoan limestones of Stevns Klint overlying the Cerithium Kalk: *Arenobulimina mohreni* BROTZEN, *Lagena gracillima* (SEGUENZA), *L. hispida* REUSS, *L. sulcatiformis* POŻ. & URB., *Robulus turbinatus* PLUMMER, *Planularia discus* (BROTZEN), *Globigerina pseudobulloides* PLUMMER, *G. triloculinoides* PLUMMER, *Bolivinoides paleocenica* (BROTZEN), *B. curta* REISS, *Guttulina problema* D'ORBIGNY, *Osangularia lens* (BROTZEN) (=*O. cordieriana navarroana* CUSHMAN) — numerous, *Pullenia americana* CUSHMAN, *Pleurostomella paleocenica* CUSHMAN, *Gavelinella pertusa* MARSSON, *Marssonella oxycona* (REUSS), *Gyroidinoides soldani* (D'ORB.) var. *octocamerata*, *Karreria fallax* RZEHAK, *Bulimina plena* BROTZEN, *Pulsiphonina prima* (PLUMMER), *Eponides lunata* BROTZEN, *Gyroidinoides turgidus* (HAGENOW), *Discorbis* cf. *limbata* (TERQUEM), *Cibicides voltziana*

TABLE 4

LITHOLOGY AND STRATIGRAPHY OF THE MOST IMPORTANT SECTIONS OF DANIAN AND MONTIAN IN MIDDLE EUROPE (MEDITERRANEAN REGION EXCLUDED)
DIAGRAMMATIC CORRELATION

Age		DENMARK		SWEDEN	BELGIUM	BELGIUM-HOLLAND		POLAND	U. S. S. R.			BULGARIA	
		Zealand	Jutland	Scania	Mons	Limburg (Canal Albert)		Central and North	Crimea	Central Georgia		Danube Basin	
		(Rosenkrantz, 1924—1963 Troelsen, 1957)	(Banke-Rasmussen, 1960)	(Brotzen, 1946, 1959)	(Marlière, 1939—1962; Wienberg Rasmussen, 1962)	(Hofker, 1960, 1962)	(Meijer, 1959)	(Pożaryski, 1960, Pożaryska, 1960, 1961, Brotzen, 1961)	(Moskvin, 1959, 1960, Morozova, 1959, 1960)	(Tzagareli, 1954, Kačarava, 1960)	(Pożaryska, present paper)	(Tzankov, 1940, 1951)	(Pożaryska, present paper)
TERTIARY	UPPER PALEOCENE Thanetian or Upper Selandian	Kerteminde marl and clay (upper part)	Kerteminde marl and clay	In erratic blocks, known as »Maglehem boulders«	Freshwater sand with lignite Tuffeau with *Ph. konincki* Limestone and sand (Heersien *)	Missing		Pamiętowo beds Detritic sandy limestone (type Tuffeau) intercalations of compact limestone	Grey-blue marl, siltstone, aleurolite and compact limestone with flints	Sandstone conglomerate, calcareous clay	Green, soft, clayish marl with *Nummulites* and *Discocyclina*, *Truncorotalia crassata*	—	Hard limestone, siliceous gaize, calcareous marl *G. aequa, G. velascoensis, G. angulata, G. pseudomenardii, Discocyclina seunesi*
	LOWER PALEOCENE Montian or Lower Selandian	Kerteminde marl (lower part) Lellinge greensand = Paleocene of Copenhagen Phosphoritic conglomerate	Glauconitic clay from Hvalløse Glauconitic sand with phosphatic nodules	Glauconitic sand and dark sandy clay *Ceratobulimina tuberculata* Conglomerate with phosphatic nodules	Lacustrine and lagunar Montian Mons limestone (Calcaire de Mons) Compact limestone Quartz and glauconite	Limestone with glauconite Me	Not observed in outcrops	Puławy beds, so-called »siwak«. Detritic sandy limestone (type Tuffeau) or calcareous gaise and intercalations of compact limestone *Lamarckina rugulosa, Ceratobulimina tuberculata, Loxostomum applinae* Coarser grain	Detritic limestone (type Tuffeau) and compact limestone with flints	Green, soft, clayish marl with *Nummulites*, *Discocyclina*, *Truncorotalia crassata*	White marl intercalations of limestone *Globorotalia angulata, G. conicotruncata, Robulus degolyeri, Lamarckina rugulosa*	Missing	
	DANIAN	Limesand Coral and bryozoan limestone (Fakse) *G. daubjergensis* Bryozoan limestone (Stevns Klint) Cerithium limestone Fish Clay	Coccolith limestone *G. daubjergensis* Bryozoan limestone Cerithium limestone	Limesand Coral limestone with flint *G. daubjergensis* Bryozoan limestone (bioherms) Compact limestone (bioherms)	Ciply limestone (Tuffeau de Ciply) *G. daubjergensis* Detritic limestone with flints Conglomerate Poudingue de la Malogne	Tuffeau non-glauconitic Md *Bel. casimirovensis* Ma Mb Mc	*Tylocidaris* sp. Tuffeau glauconitic sandy Me *G. daubjergensis*	Sochaczew beds Marl and calcareous opoka with intercalations of compact limestone *G. daubjergensis* Glauconitic sand with phosphatic nodules	Glauconitic, calcareous, arenaceous marl *G. daubjergensis* Glauconitic marl with phosphatic nodules	White marl intercalations of limestone *Globorotalia angulata, G. conicotruncata, G. daubjergensis* White limestone intercalations of marls	Missing White limestone with marls; small, smooth *Globigerina*	Hard limestone, calcareous marl, sandy limestone *Discocyclina seunesi* Terra rossa	Missing
CRETACEOUS	UPPER MAASTRICHTIAN	White chalk	White chalk	White chalk	Detritic limestone (Tuffeau St. Symphorien)	Chalk of Maastrichtian age	Tuffeau non-glauconitic Md Mc Mb Ma	Opoka (siliceous limestone) with marls	Arenaceous marl and calcareous sandstone	White marl	White limestone	White limestone	

*) ~~~~ = unconformity or hiatus.

(D'ORBIGNY), *C. simplex* BROTZEN, *C. commatus* MOROZOVA, *C. proprius* BROTZEN, *Anomalina acuta* (PLUMMER) and *A. danica* BROTZEN.

The following microfaunal assemblage was found by the present writer in the lower strata of the Upper Danian (*Tylocidaris bruennichi* horizon) at Fakse: *Spiroplectammina wilcoxensis* CUSHMAN & PONTON, *Lagena sulcatiformis* POŻ. & URB., *Vaginulina gladius* (PHIL.), *Robulus turbinatus* (PLUMMER), *Frondicularia biformis* MARSSON, *Guttulina problema* D'ORBIGNY, *Globigerina daubjergensis* BRONN., *G. pseudobulloides* PLUMMER, *Mississippina binckhorsti* (REUSS), *Alabamina midwayensis* BROTZEN, *Marssonella oxycona* (REUSS), *Pulsiphonina prima* (PLUMMER), *Bulimina plena* BROTZEN, *Planulina limbata* BROTZEN, *Pullenia coryelli* WHITE, *P. americana* CUSHMAN, *Gyroidinoides subangulata* (PLUMMER), *G. soldanii* (D'ORBIGNY), *Karreria fallax* RZEHAK, *Gavelinella pertusa* MARSSON, *Eponides frankei* BROTZEN, *Tappanina selmensis* (CUSHMAN), *Cibicides voltzianus* (D'ORBIGNY), *C. lobatulus* (WALKER & JACOB), *C. complanatus* (REUSS), *Anomalina danica* BROTZEN, *A. acuta* (PLUMMER) and *Cymbalopora radiata* HAGENOW.

In the uppermost Danian strata of Denmark, in limesand, belonging to the *Tylocidaris vexillifera* zone (though this fossil is very rare here) in NW Denmark, the present writer recorded the following species: *Globigerina daubjergensis* BRONN., *G. pseudobulloides* PLUMMER, *G. triloculinoides* PLUMMER and *Pulsiphonina prima* (PLUMMER).

From the Upper Danian of Jutland in the Mønsted limestone quarry BANG quotes (1960, Guide to exc. C-47, see RASMUSSEN, 1960): *Ataxophragmium frankei* BROTZEN, *Pulsiphonina elegans* BROTZEN, *Osangularia lens* BROTZEN, *Karreria fallax* RZEHAK, *Anomalinoides nobilis* BROTZEN, *Discorbis binckhorsti* (REUSS), *Eponides frankei* BROTZEN and *Cibicides* sp.

TABLE 5

STRATIGRAPHY OF DANIAN BEDS IN DENMARK
(adapted from ROSENKRANTZ, 1937, modified by TROELSEN, 1957)

Stages	Lithology		Localities	*Tylocidaris* zones
SELANDIAN	Glauconite clay, silt and conglomerates + 6 m.		Copenhagen	no *Tylocidaris*
	minor(?) hiatus			
DANIAN	Danskekalk formation	»Calcarenite« with chert 30—50 m.	Copenhagen, Saltholm	*T. vexillifera* SCHLÜTER
		minor hiatus		
		Bryozoan reef (bioherms) with chert; locally coral reef + 66 m.	Fakse, Stevns Klint	*T. bruennichi* RAVN
				T. abildgaardi RAVN
				T. oedumi BRÜNNICH NIELSEN
		minor hiatus		
		»Calcilutite« with marl at base ca. 0·5 m.	Stevns Klint	no *Tylocidaris*
	major hiatus			
MAASTRICHTIAN	White chalk with chert + 20 m.		Stevns Klint	*T. baltica* SCHLÜTER

In the Hvalløse quarry, BANG (1960) quotes: *Textularia* sp., *Pyramidina crassa* BROTZEN, *Eouvigerina selmensis* (CUSHMAN), *Pulsiphonina eklundi* (BROTZEN), *Alabamina midwayensis* BROTZEN, *Gyroidinoides pontoni* BROTZEN, *Nonion* cf. *graniferum* (TERQUEM), *Globigerina daubjergensis* BRONN. and *G. pseudobulloides* (PLUMMER).

The following foraminiferal assemblage was found by the present writer in the Upper Danian of the same Hvalløse quarry: *Globigerina triloculinoides* PLUMMER, *G. daubjergensis* BRONN., *G. pseudobulloides* PLUMMER, *G. varianta* SUBB., *Allomorphina halli* JENN., *Anomalina danica* BROTZEN, *Nonionella ovata* BROTZEN, *Fissurina marginata* (WALKER & BOYS), *Lagena ellipsoidalis* SCHWAGER, *L. sulcatiformis* POŻ. & URB., *L. gracilicosta* REUSS, *L. hispida* REUSS, *Nonionella troostae troostae* HOFKER, *Glandulina laevigata* (D'ORBIGNY), *Guttulina muensteri* (REUSS) and *Bulimina ovata* D'ORBIGNY.

In all the Danian localities in Denmark known to the present author the foraminiferal remains are rather badly preserved and their identification is impeded by the fact that they are recrystallized. Their shells are never smooth, but coated by a fine-crystalline film of calcite carbonate. Planktonic species of foraminifers and those belonging to the genera *Lagena* and *Fissurina* predominate. From the Danian of southern Scandinavia BERGGREN (1962*b*) quotes and illustrates only 4 of the most common planktonic species, which have been previously fully described and illustrated by TROELSEN (1957).

SELANDIAN IN DENMARK

(Text-plate IX)

The Lower Paleocene sediments — Selandian — are developed in Denmark as well as in Sweden. They are especially well developed on the islands Zealand and Fyn. In Jutland they only occur in the north-eastern part, i.e. in the Aarhus and Randers region. Moreover, they are known from several borings. The Danish Paleocene sediments are called Selandian, according to ROSENKRANTZ'S definition (1924).

Selandian comprises a series of green, glauconitic sediments, overlying the limesand or the white bryozoan limestones of Danian age, and underlying tuff-bearing series of the lowermost Eocene. Its lower boundary is easily to recognize from a palaeontological, as well as from a petrographical point of view.

The earliest known deposits of the Danish Paleocene are the greensand sediments at Lellinge, a small locality on Zealand, situated 30 km. south-west of Copenhagen. FORCHHAMMER described them in 1843, first as older than the Senonian white chalk, later on as younger than the white chalk, but earlier than the Saltholm limestones of Upper Danian age. Some years later the same author described them as younger than the Saltholm limestones and placed the Lellinge greensand in the uppermost part of the Cretaceous system. Further, VAN KOENEN (1886) stated that the greensand at Lellinge must be related to the Vestre Gasvaerk sediments, found in some excavations in Copenhagen, and must be placed into the Paleocene — Tertiary. During excavating work in the harbour of Copenhagen, the knowledge of the Paleocene's greensand was enlarged. A conglomerate was found there in the contact with the Saltholm limestone. It was named *Crania* limestone, because it contained many shells of *Crania tuberculata* NILS. The conglomerate was first placed by GRØNWALL (1899) into the Danian, in spite of the fact that the type of rock differs considerably from the Danian one. Later on, ROSENKRANTZ'S careful investigations (1920) of the *Crania* limestone sections showed that the hard *Crania* conglomerate constitutes the basal part of the Paleocene greensand and is provisionally named

the Upper *Crania* limestone, while other parts of GRØNWALL's *Crania* limestone belongs to the Uppermost Danian and is named Lower *Crania* limestone. Meantime the Kerteminde marl, having a wide distribution in west Zealand and Funen had been discovered and placed into the lowermost Tertiary. GRØNWALL stated that the main part of this series is later than the Lellinge greensand series. Finally it was stated that the Paleocene in Denmark was divided into two substages — groups. The lower being glauconitic comprises greensand and the lower Kerteminde's marl, upper group comprises rather clayish, partly shaly clayish series, so-called Upper Kerteminde »marl«. The strata of the Upper Kerteminde marl are mostly noncalcareous. The term »marl« therefore is not quite relevant.

The petrology of the sedimentary rocks of Denmark is given by GRY (1935).

Recently ROSENKRANTZ (1963 — Coll. Wien) stated that the Lower Selandian is corresponding with the upper part of Calcaire grossier de Mons, while the Upper Selandian — with Thanetian of Belgium.

The following foraminiferal assemblage was stated by BANG (in RASMUSSEN, 1960, Guide to exc. C37) in Hvalløse quarry in northern Jutland Lower Paleocene glauconitic clay: *Ataxophragmoides frankei* BROTZEN, *Robulus klagshamnensis* BROTZEN, *Planularia discus* (BROTZEN), *Citharina plumoides* (PLUMMER), *Dentalina multilineata* BORN., *Tappanina selmensis* (CUSHMAN), *Eponides lunata* BROTZEN, *Gavelinella lellingensis* BROTZEN, *Cibicides proprius* BROTZEN, *Anomalinoides danica* (BROTZEN), *A. nobilis* BROTZEN, *Osangularia* sp., *Karreria fallax* RZEHAK and *Ceratobulimina tuberculata* BROTZEN.

The present writer recorded in the sample from Hvalløse quarry, 20 cm. above the conglomerate, the following foraminifers: *Clavulina parisiensis, Trochammina inflata, Pseudoglandulina cylindrica, Lagena sulcatiformis, L. ellipsoidalis, L. hispida, L. vulgaris, L. geometrica, L. hexagona, L. striatopunctata, Fissurina seguenziana, Svenia megalopolitana, Marginulina pediformis, M. plummerae, Citharina plumoides, Planularia discus, Robulus degolyeri, R. rancocasensis, Bulimina ovata, B. paleocenica, B. trigonalis, B. arkadelphiana, Tappanina selmensis, Ramulina* sp., *Sigmomorphina brotzeni, S. pseudoregularis, Glandulina laevigata, Guttulina amygdaloides, G. problema, G. irregularis, G. communis, Globulina gibba, Gyroidina subangulata, Valvulineria* sp., *Allomorphina halli, Eponides lunata, Bolivinoides peterssoni, Pulsiphonina prima, Cibicides proprius, C. ekblomi, C. sahlstroemi, C. floridanus, C. succedens, Anomalinoides nobilis, A. danica, Globigerina triloculinoides, G. compressa, G. pseudobulloides, G. daubjergensis, Pullenia americana, Ceratobulimina tuberculata* and *Stensioeina caucasica.*

In Lellinge Lower Selandian greensands the present writer recorded: *Trochammina inflata, Lagena sulcatiformis, L. reticulata, L. multicostata, L. ellipsoidalis, Svenia megalopolitana, Pseudoglandulina cylindrica, Marginulina pediformis, Saracenaria jarvisi, Astacolus trigonatus, Planularia discus, Frondicularia biformis, Robulus klagshamnensis, R. hornerstownensis, R. wilcoxensis, Guttulina amygdaloides, G. roemeri, G. communis, Bulimina ovata, B. paleocenica, Pleurostomella paleocenica, Angulogerina cuneata, Sigmomorphina brotzeni, S. pseudoregularis, S. geijeri, Tappanina selmensis, Bolivinoides paleocenica, Alabamina midwayensis, Eponides lunata, Pullenia americana, P. coryelli, Gavelinella lellingensis, Allomorphina halli, Anomalinoides nobilis, A. danica, Osangularia cordieriana navarroana (=O. lens), Gyroidinoides octocamerata, Ramulina* sp., *Guembelina wilcoxensis, Cibicides succedens, C. proprius, Globigerina triloculinoides, G. daubjergensis, Globigerinella* sp. and *Rosalina ystadiensis.*

In a sample received kindly from Professor A. ROSENKRANTZ from Kerteminde marl, the present author has recorded following species: *Spiroplectammina laevis, Clavulina parisiensis, Bulimina paleocenica, B. ovata, B. arkadelphiana, Svenia megalopolitana, Guttulina muensteri, G. problema, G. communis, Glandulina laevigata, Sigmomorphina brotzeni, Stensioeina caucasica,*

Pulsiphonina prima, Eponides lunata, Allomorphina hofkeri n. sp., *Gyroidina subangulata, Pullenia americana, Tappanina selmensis, Nonionella troostae troostae, Alabamina midwayensis, Osangularia cordieriana navarroana (=Parrella lens), Ceratobulimina tuberculata, Globigerina daubjergensis, G. (Eoglobigerina) quadrata, Polymorphina* sp., *Anomalina danica, Cibicides* sp. (probably new species).

In another sample received also from Professor A. ROSENKRANTZ from the Vestre Gasvaerk excavations made in 1930 (Gas container no. 5, level — 6·17 m. to 6·34 m.) the present writer has recorded following species: *Spiroplectammina* sp., *Robulus rancocasensis, Saracenaria hamata, Bulimina ovata, B. paleocenica, Tappanina selmensis, Guttulina muensteri, Eponides toulmini, E. lunata, Pulsiphonina prima, Alabamina midwayensis, Pullenia americana paleocenica, Allomorphina halli, Bolivinopsis scanica, Pseudoparrella limburgensis, Rosalina ystadiensis, Valvulineria ravni, Gyroidinoides soldanii, Ceratobulimina tuberculata, Globigerina daubjergensis, G. triloculinoides, G.* cf. *varianta, Cibicides commatus, C. simplex, C. succedens, C. sahlstroemi, Anomalina danica, A. ekblomi, Anomalina* sp. (probably n. sp.).

DANIAN IN SWEDEN

(Text-plate IX, Table 6)

In southern Sweden (Scania) the sediments of the Danian and Upper Maastrichtian — Stevnsian are well exposed in the huge Limhamn quarry near Malmö, where they have been described in detail by BROTZEN (1959). Upper Maastrichtian rocks exclusively outcrop at the bottom of the quarry. They consist of white, rather hard limestones, indistinctly stratified, containing grey-black flints. Macroscopically they do not differ hardly from the overlying Danian sediments. They contain *Scaphites (Hoploscaphites) constrictus* SOW., an index ammonite species of the Maastrichtian, also *Echinocorys ovata* and spines of *Tylocidaris baltica*. In Sweden these strata do not — as in other European areas — terminate in an indurated layer of typical hard ground.

In Limhamn, Danian rocks represented by an eighty metres thick series of soft, white bryozoan-coccolithic limestones, overlie the Upper Maastrichtian (Stevnsian) deposits. The bryozoans there occur as lense-like lenticular accumulations, forming typical bioherms. Their thickness is several times that of the bryozoan bioherms in the Danian of Denmark, but their length is considerably shorter. These lenses are domed strongly inflated towards the top. Fine coralline accumulations occur locally on the margins of the lenses. Towards the top of the Danian series, the number of coralline accumulations gradually increases so as to become the predominant element of the limestones in the top of the quarry, from where the bryozoan bioherms have already disappeared. Only in the coralline limestones do these sediments display some stratification. Flints occur in both types of limestone as large, black, angular concretions to a certain extent overlapping and fringing the individual bryozoan structures — bioherms.

The uppermost parts of the Upper Maastrichtian — Stevnsian is rather insignificantly indurated. The small, barely detectable depressions on its surface are filled in by sediment from the overlying bryozoan limestones. These minute pockets, indicating the erosion of the Maastrichtian surface, seem to suggest the existence of a certain temporal hiatus, corresponding to the indurated hard ground layer between the Upper Maastrichtian and the Danian, found in other parts of Europe. Three bryozoan bioherm horizons have been distinguished by BROTZEN

(1959) at Limhamn: the lowermost belongs to the Lower Danian, the two higher — to the Middle Danian.

The zonation of the Danian is established on the occurrence of spnies of the *Tylocidaris*. The species of *Tylocidaris* change in different zones and some years earlier have been used as guide fossils in Denmark.

In the Lower Danian of Sweden, *Echinocorys sulcatus* occurs side by side with the characteristic echinid spines of *Tylocidaris oedumi* BRÜNNICH NIELSEN, *T. abildgaardi* RAVN and *T. windi* BROTZEN. The thickness of the Lower Danian averages ca. 10 m.

The boundary between the Upper and the Middle Danian is well marked as the second and third bioherm systems, belonging to the Middle Danian, differ somewhat in character from that of the first Lower Danian system. In the Middle Danian one can find the index echinid form *Tylocidaris rosenkrantzi* BROTZEN, which characterizes the second system of bioherms, also *T. bruennichi* RAVN — an index form for the third system. Each of these systems is ca. 35 m. in thickness and has a rather poor macrofauna. The only abundant forms are *Echinocorys sulcatus*, *E. obliquus*, *Crania tuberculata* NILS. and *Hercoglossa danica* (SCHLOTHEIM). The occurrence of *H. danica* in Sweden as in Denmark seems confined to the Middle Danian. The Middle Danian attains a considerable thickness. In southern Sweden it is 100 m. and increases distinctly to the south-east, where the bryozoan limestones disappear and are replaced by pelitic limestones.

The Upper Danian of Sweden has been described in detail by BROTZEN (1938, 1948, 1959). BROTZEN's description provides a clear picture of this horizon which is easily distinguishable from the Middle Danian. It is completely stratified, consisting of alternating beds of soft and hard limestones, and of more or less irregularly embedded black flint layers, one of which attains a thickness of as much as 0·5 m. The bryozoan bioherms, so characteristic of the Middle and Lower Danian of Sweden, are absent, though quite a number of detached bryozoan remains are encountered in the sediment. The limestones are typical, rather soft and pelitic coccolithic rocks crowded with calcite crystals. This type of Upper Danian rock is known under various names by various authors. Thus they are called limesand, limestone or »Saltholm limestone« — after the name of an island, where Upper Danian beds are particularly well developed, »coccolith limestone« in view of the presence of coccoliths, or »calcarenite« used by TROELSEN (1957) because of the abundance of calcite crystals. These limestones contain numerous coccoliths, mostly belonging to *Cribrosphaerella danica* BROTZEN (1959). The faunal changes between the Middle and the Upper Danian are clearly indicated by the appearance in the Upper Danian of *Tylocidaris vexillifera* SCHLÜTER (according to ROSENKRANTZ), *Tylocidaris herupensis* quoted by BROTZEN, there is only a form of *Tylocidaris vexillifera*. BROTZEN stated the absence in Denmark of the lower part of the Middle Danian which, according to him, has probably been outwashed, however in ROSENKRANTZ's opinion (oral information) this horizon is present in Denmark in Stevns Klint.

According to VOIGT (1929) and ROSENKRANTZ (1931), the basal layer of the Upper Danian limesand series in the northern part of the Limhamn quarry is formed by a coarse conglomerate, consisting of glauconite-coated limestone pebbles. Similar conglomerates occur at the same level on Saltholm and in Herfolge (Zealand) (ROSENKRANTZ, 1925). In Zealand, the *T. bruennichi* zone, representing the higher part of the Middle Danian, rests directly as in Scania on the *Tylocidaris rosenkrantzi* zone.

The Upper Maastrichtian (Stevnsian) at Limhamn is characterized by the presence of such index foraminifers as *Neoflabellina reticulata* (REUSS) and *Stensioeina pommerana* (BROTZEN).

According to BROTZEN (1959) the following forms are likewise characteristic of that stage: *Bolivinoides dorreeni* FIN., *B. peterssoni* BROTZEN s. str., *Dorothia bulletta* (CARS.), *Pseudouvigerina cimbrica* (TROELSEN), *P. rugosa* BROTZEN, *Eponides frankei* BROTZEN, *Pseudotextularia elegans* RZEHAK and *Cibicides bosqueti* (MARSSON).

Besides the above mentioned species the following important forms, which do not pass from the Maastrichtian to the Danian, are also present there: all the species of genus *Biglobigerina*, *Rugoglobigerina*, *Globotruncana*, *Frondicularia*, excluding *F. biformis* MARSSON, *Bolivina incrassata* REUSS and *Pseudotextularia acervulinoides* (EGGER).

According to BROTZEN (1959), the Danian stage is characterized by the following foraminiferal assemblage:

In the Lower Danian: *Globigerina daubjergensis* (BRONN.), *G. pseudobulloides* PLUMMER, *G. compressa* PLUMMER and *G. trivialis* SUBB., the last named species having made its appearance already in the higher strata of the Stevnsian.

In the Middle Danian: *Ataxophragmoides frankei* BROTZEN, *Marssonella oxycona* (REUSS), *Bolivina selmensis* CUSHMAN, *Bulimina plena* BROTZEN, *Spirillina vivipara* EHR., *S. recta* BROTZEN, *S. subornata* BROTZEN, *Conorbina conula* BROTZEN, *Pullenia* aff. *americana* CUSHMAN, *Rosalina* aff. *ystadiensis* BROTZEN, *Discorbis binckhorsti* (REUSS), *Valvulineria laevis* BROTZEN, *Gyroidina nitida* (REUSS), *Gavelinella bullata* BROTZEN, *Eponides* aff. *lunata* BROTZEN, *Cibicidoides constricta* (HAGENOW), *Cibicides voltzianus* (D'ORBIGNY), *C. beaumontianus* (D'ORBIGNY), *C.* aff. *lobatulus* (WALK. & JAC.), *C. hemisphaera* (REUSS), *Anomalinoides danica* (BROTZEN), *A.* aff. *acuta* (PLUMMER), *Karreria fallax* BROTZEN, *Alabamina dorsoplana* (BROTZEN), *Osangularia lens* BROTZEN, *Coleites reticulosus* PLUMMER, *Globigerina triloculinoides* PLUMMER, *G. daubjergensis* BRONN., *G. pseudobulloides* PLUMMER and *G. compressa* PLUMMER.

Karreria fallax and *Coleites reticulosus*, which have already appeared in the Middle Danian, become very numerous in the Upper Danian of Sweden. The new elements in Swedish Upper Danian are represented by: *Pseudoclavulina anglica* CUSHMAN, *Gaudryina* cf. *faujasi* (REUSS), *Planularia discus* (BROTZEN), *Astacolus paleocenicus* BROTZEN, *Citharina plumoides* (PLUMMER), *Sigmomorphina soluta* BROTZEN, *Bulimina paleocenica* BROTZEN, *Pyramidina curvisuturata* (BROTZEN), *Angulogerina europaea* CUSHMAN & EDW., *Elphidiella prima* (TEN DAM), *Cibicides sahlstroemi* BROTZEN and *Coleites danicus* BROTZEN.

A great majority of the foraminifers, which belong to the Danian assemblage in Sweden, pass into the Lower Paleocene. The Maastrichtian-Danian boundary is well indicated in contrast to that between the Danian and the Paleocene.

BROTZEN'S (1959) list of planktonic foraminifers of the Lower Danian of Limhamn is not quite complete. A sample of the Lower Danian of Limhamn, collected by the present writer with generous help of Dr F. BROTZEN in 1956, 3 m. above the Maastrichtian-Danian boundary, yielded the following assemblage of benthonic foraminifers: *Ammobaculites* cf. *paleocenicus* CUSHMAN, *Frondicularia biformis* MARSSON, *Robulus turbinatus* (PLUMMER), *Osangularia lens* (BROTZEN) (= *O. cordieriana navarroana* CUSHMAN), *Anomalina danica* BROTZEN, *A. acuta* (PLUMMER), *Mississippina binckhorsti* (REUSS), *Pullenia americana* CUSHMAN, *P. coryelli* WHITE, *Gavelinella pertusa* MARSSON, *Gyroidinoides turgidus* (HAGENOW), *Eponides toulmini* BROTZEN, *Bulimina plena* BROTZEN, *Cibicides voltzianus* (D'ORBIGNY), *C. beaumontianus* (D'ORBIGNY), *C. proprius* BROTZEN, *C. simplex* BROTZEN, *Pseudopolymorphina geijeri* BROTZEN, *Guttulina lactea* WALK. & JAC., *G. problema* D'ORBIGNY, *G. irregularis* D'ORBIGNY and *Bolivinoides peterssoni* BROTZEN.

The numerous macrofaunal remains encountered in the Danian deposits of Denmark have been quoted by several authors (RAVN, BRÜNNICH NIELSEN, ROSENKRANTZ et al.) and are

of considerable importance for the stratigraphy, as they are mostly representatives of Danian fossils. In the Danian series at Limhamn the occurrence of spines of the echinid genus *Tylocidaris* is also noted. They provide evidence for dividing the Danian series into 4 horizons, as in Denmark. In Sweden, BROTZEN (1959) has worked out a nearly complete stratigraphy of the Danian deposits which outcrop in the Limhamn quarry. Beginning with the Maastrichtian we have there the complete series of the Lower and the Middle Danian, as well as the lower part of the Upper Danian. BROTZEN's stratigraphy (1959) of these horizons is shown in Table 6.

TABLE 6

STRATIGRAPHY OF DANIAN BEDS IN SWEDEN
(adapted from BROTZEN, 1959)

Stratigraphy	Thickness (in m.)	Horizon	Type of rocks and fauna
UPPER DANIAN	12—20	*Tylocidaris* * *vexillifera* SCHLÜTER (*herupensis* WIND)	Hard and soft coccolith limestone beds, intercalated with flint beds or strata with irregular flint nodules
MIDDLE DANIAN	about 30 30—35	*Tylocidaris bruennichi* RAVN and *Tylocidaris rosenkrantzi* BROTZEN	*Hercoglossa danica* (SCHL.) Bryozoan bioherms, and bryozoan and coralline compact limestones *Crania tuberculata* NILS.
LOWER DANIAN	8—12	*Tylocidaris oedumi* BRÜNNICH NIELSEN	Soft bryozoan bioherms without coralline limestones, with many flint nodules, irregularly embedded *Echinocorys sulcatus* GOLDF. *Brissopneustes danicus* SCHL.
STEVNSIAN (UPPER MAASTRICHTIAN)	about 250	*Tylocidaris baltica*	Hard chalk intercalated by grey, clayish layers, thin. Black flint nodules. *Echinocorys sulcatus* GOLDF., *Echinocorys ovata, Scaphites (Hoploscaphites) constrictus* SOW.

* *Tylocidaris herupensis* BROTZEN (WIND) will be abandoned by ROSENKRANTZ (oral information). The Scanian specimens belong to *Tylocidaris vexillifera* SCHLÜTER which is a good Upper Danian species.

SELANDIAN IN SWEDEN

(Table 4)

The Lower Paleocene sediments, called in Sweden as well as in Denmark (ROSENKRANTZ, 1924) Selandian, are developed in Sweden in the 2 following regions of Scania: at Klagshamn and Ystad. We can observe only their remains in tectonic depressions, where they are protected against erosion, where its thickness reaches 18 m. The Paleocene beds were well exposed at Klagshamn in a quarry, now filled with water. They are lying there in a depression. According to BROTZEN (1948), the Lower Paleocene conglomerate, about 10 cm. in thickness, overlies the Upper Danian limestone. The conglomerate is composed mainly of Danian limestone pebbles, phosphatic nodules, bone fragments, fish teeth and fossils, redeposited from the Danian sediments just as is the case of the basal conglomerate of the Selandian in Denmark. There is

unconformity in the contact between the Paleocene conglomerate and the uppermost Danian limestones as in Denmark. Burrows and cavities penetrate down into the top half metre of Danian limestones which are hardened. The burrows are filled with greenish glauconitic sand, penetrating horizontally into fissures between the Danian limestones. Some clayish greensand, containing a single coral *Sphenotrochus latus*, are exposed at Klagshamn and can be noticed in borings south of Malmö and near Ystad.

A similar conglomerate with pebbles and phosphatic nodules was known earlier in Denmark. (The harbour and the Vestre Gasvaerk in Copenhagen and Hvalløse). In both conglomerates, in Sweden as well as in Denmark, numerous fossils such as molluscs, brachiopods, echinoderms, are to be found. The majority of them are reworked. *Crania tuberculata* and *Crania posselti* are also present there derived. The conglomerate gradually changes into green sediment without pebbles and nodules and contains a great deal of clayish matter and very abundant foraminifers described by BROTZEN (1948). Macrofossils (belonging mainly to pelecypods and gastropods), on the contrary, are rather rare and in a bad state of preservation. There are few arenaceous foraminifers and only two species are characteristic for layers of this age, while in Poland much more arenaceous species can be found. The family Miliolidae is represented in the Swedish Lower Paleocene by 4 species only, and in Poland by 2 species, whereas in both countries the Lagenidae occur in great abundance, their frequency is about 6 per cent. Some of the species belonging to this family are very important in stratigraphy and restricted to the Paleocene, e.g. species belonging to big *Robulus*, *Palmula*, *Planularia* and *Astacolus*. The Polymorphinidae and Buliminidae are abundant also, but the most important are species of the Rotaliiformes group. According to BROTZEN (1948), two species: *Lamarckina naheolensis* and *Ceratobulimina perplexa* would be regarded as index fossils, while *Lamarckina rugulosa*, the index species in Midway and Poland, is lacking in Sweden. The Lower Selandian of Denmark may be considered as an equivalent of the Montian of Belgium, which conformably covers the Tuffeau de Ciply. Danian and Lower Selandian is provisionally termed by ROSENKRANTZ the Dano-Paleocene. This author considers this series of strata as a unit lying just below the Thanetian.

The Middle Paleocene sediments are known in Sweden only as boulders containing a rich mollusc and foraminiferal fauna, which indicates sedimentation conditions far away from a shore line (BROTZEN, 1960). They are known as so-called »Maglehem boulders«. They represent a facies very different from other localities of the occurrence of the Paleocene sediments in Sweden.

DANIAN AND MONTIAN IN BELGIUM AND THE NETHERLANDS

(Text-plate IX; Table 4)

The Danian and Paleocene sediments occur in two regions of Belgium, i.e. in the Mons Basin, south-west Belgium, and the Limburg Region located in north-east Belgium and extending to the territory of the Netherlands. These regions are divided by the Brabant massif which forms the central part of Belgium and stretches north-west of the Ardennes.

THE MONS BASIN

The Mons Basin constitutes a small area, situated in the eastern peripheries of the great Paris Basin, its main feature being a more or less complete sequence of sediments from the boundary of the Cretaceous and the Tertiary. In the centre of the Paris Basin there are considerable

hiatuses, covering at least the entire Maastrichtian. On the other hand, the area of Belgian-Dutch Limburg constitutes a part of the great North-European Upper Cretaceous basin, extending from England to Poland. During the Danian and Lower Paleocene, these basins were probably temporarily connected in the area of central Belgium and, certainly, in the coastal territories of north-west Belgium. Hence — the considerable faunistic, and partially, lithological similarities.

In the Mons Basin, the transgression products of the Middle Albian, successively covered by the deposits of the Upper Cretaceous, the Maastrichtian and the Danian included, with stratigraphical hiatuses seldom met with, rest on Wealdian sediments. From the Coniacian up to and including the Lower Maastrichtian, sediments are almost purely carbonate in character, represented in this basin by a series, called »Assise de Spiennes«, consisting of the layers called »Craie phosphatée de Ciply« and »Craie de Spiennes« (MARLIÈRE, 1954). This is a chalk facies, while a detritic facies, extending up to and including the Montian begins in the Maastrichtian, resting on the former. These are yellowish, detritic limestones of an organic origin, of the »tuffeau« type, compact or porous which — in the Maastrichtian — contain belemnites, but do not contain any ammonites.

THE DANIAN »TUFFEAU DE CIPLY«

A series of white detritic limestones, called »Tuffeau de Ciply« rest on the »St. Symphorien« series of the Upper Maastrichtian sediments. These limestones are lithologically very similar to the Maastrichtian tuffeau of the Albert Canal in the Limburg Region. They consist of light, soft, very loose and, as a rule, considerably homogeneous rocks, containing very large, irregularly shaped, gray-black flints which outcrop in the form of a few strata. The macrofauna of the Tuffeau de Ciply series is, in general, very poor. There are no ammonites, belemnites and inoceramids. The lower part of this series abound in Bryozoa remains. The general thickness of the Tuffeau de Ciply series in outcrops amounts to over 20 m.

The detritic limestones of the Tuffeau de Ciply rest on the so-called »Poudingue de la Malogne« layer which separates this series from an underlying bed, called »Tuffeau de St. Symphorien« of uppermost Cretaceous, i.e. Upper Maastrichtian age (MARLIÈRE, 1954). Poudingue de la Malogne plays the role of a basic conglomerate of the Danian transgression, whereas Tuffeau de Ciply seems to be not separated by any conglomerate from the Montian limestones, but rests on them, and gradually passes into them. It is only the sediment from the boundary between these two series that contains an insignificant admixture of polished grains of quartz and glauconite (MARLIÈRE, 1957). However, such admixture of detritic grains is repeated in layers, from time to time, in this series. Besides outcrops, the Tuffeau de Ciply limestones were found when an artesian well was drilled at the site of the Polytechnic College at Mons. They were recorded at depths, ranging from 111·5 m. to 151 m. and, therefore, their thickness in that drilling reached about 40 m. They constitute the third local level, with Cytherelloidea, previously (1958) numbered by MARLIÈRE in the Montian and now (also by him, 1962) in the Danian. The entire material of that drilling was elaborated in detail by MARLIÈRE (1957, 1958), who — on the basis of the ostracods — divided it into 3 levels: 1) *Triginglymus* beds, 2) *Cytheretta* beds and 3) *Cytherelloidea* beds.

The Tuffeau de Ciply detritic limestone series was originally regarded by DEWALQUE (1868) as part of the Maastrichtian. This opinion was shared by CORNET and BRIART (1885). Later, this series was referred to the Tertiary (RUTOT, 1885; VAN DER BROECK, 1885). This view was supported by LERICHE (1937), GLIBERT (1957) and MARLIÈRE (1962, presented at the Bordeaux Colloqium). At present, the Danian age is ascribed to these limestones. It was *Globigerina*

daubjergensis, found by TROELSEN in the Tuffeau de Ciply and confirmed by LOEBLICH and TAPPAN (1957), that indicated the Danian age of this series. Many faunistic analogies between the Tuffeau de Ciply and the Danian of the type localities (Fakse and Stevns Klint) have been mentioned by E. VINCENT (1930), mostly concerning mollusks, and quite recently recorded by WIENBERG RASMUSSEN (1962). The following forms have been determined by him as common and entirely restricted to the Danian: *Tylocidaris bruennichi*, *Ceramaster granulatus*, *Bourgeticrinus danicus*, *Ditrupa schlotheimi*, *Democrinus maximus*, *Megathyris bruennichi*, *Argyrotheca pindborgi* and *Spirorbis ascendens*. Consequently, an opinion was expressed by WIENBERG RASMUSSEN that the Tuffeau de Ciply series most probably represents the Middle Danian age. On the other hand, the Lower Paleocene (Lower Montian) age of the Tuffeau de Ciply is maintained by HOFKER (1960, 1961).

Several species of ostracods common to the Tuffeau de Ciply and the »post-Maastrichtian« of the Belgian-Dutch Limburg, among others, *Caudites* aff. *orchidea* BOSQUET, *Brachycythere pustulosa* MARLIÈRE and *Puriana ciplyensis* MARLIÈRE, were found by DEROO (1959) in the level containing Cytherelloidea, now reckoned in the Tuffeau de Ciply.

The following species of foraminifers, found in the Tuffeau de Ciply and considered by HOFKER (1961) as belonging to the Montian, are: *Globorotalia pseudomenardii*, *G. ehrenbergi* and *G. pusilla laevigata*. A complete absence of the *Globigerina pseudobulloides* and *G. daubjergensis*, cited by LOEBLICH and TAPPAN (1957), has been noted by HOFKER who found instead an assemblage of *Globorotalia* analogous to that, well-known in the Paleocene of central Trinidad (LOEBLICH & TAPPAN, 1957; BOLLI, 1957). This, however, has not been confirmed by any other author. It is true that these foraminifers are very poorly preserved, heavily incrusted and, thus far, have not been elaborated in detail. The author of the present paper has identified the following species contained in a sample of the Tuffeau de Ciply, taken at a height of 6 m. above the base of this series: *Textularia bunensis* v. BELLEN, *Marssonella keijzeri* v. BELLEN, *Angulogerina* cf. *wilcoxensis* CUSHMAN & PONTON, *Guttulina problema* D'ORB., *Globulina gibba* D'ORB., *G. arenacea* BROTZEN, *Sigmomorphina soluta* BROTZEN, *Karreria fallax* RZEH., *Pulsiphonina prima* (PLUMMER), *Rotalia saxorum* D'ORB., *Eponides toulmini* BROTZEN, *E. minimus* (CUSHM.), *Anomalina ekblomi* (BROTZEN), *A. danica* BROTZEN, *A. burlingtonensis* (JENNINGS), *Cibicides ornatus* v. BELLEN, *C. proprius* BROTZEN and *C. commatus* MOROZOVA. This is an assemblage of foraminifers common to the Danian and Montian of Poland, but still lacking the typically Paleocene elements, characteristic of the Lower Paleocene of Sweden, Denmark, Poland and other countries. These lacking species are: *Ceratobulimina tuberculata*, *Lamarckina rugulosa*, *L. naheolensis*, *Loxostomum applinae*, *Robulus degolyeri*, *Astacolus gryi* and some others. At any rate, the absence of the Paleocene elements from the foraminiferal fauna of the Tuffeau de Ciply indicates its Danian age.

THE MONTIAN »CALCAIRE DE MONS«

A series of the Calcaire de Mons sediments rests on the Tuffeau de Ciply detritic limestones and is not separated from them by any distinct unconformity. These are thick series, so-called »Calcaire grossier«, here and there containing a rich fauna of pelecypods and gastropods. Brachiopods and fresh water forms already occur within this assemblage. Pelecypods and gastropods are accumulated to such an extent that, in some places, the rocks form typical »lumachelles«. Here and there the limestones are coralline in character and in the lower part — organo-detritic with intercalations of a hard, compact limestone. The Upper Montian fresh water sediments rest on this series (MARLIÈRE, 1954). They are represented by gray and black marls with lignite intercalations.

No Montian limestones outcrop on the surface of the soil. They were found in 1903 when an artesian well was being drilled at the site of the Polytechnic College at Mons. Their thickness amounted there to 45 m. It has been made clear from MARLIÈRE's elaboration (1957, 1962), based on ostracod fauna that three horizons can be distinguished within the Calcaire de Mons series, of which only the two are considered at present to belong to the Montian, i.e. the *Triginglymus* and *Cytheretta* beds. Foraminifers have not as yet been fully elaborated. It should be emphasized that they are rather poorly preserved, in some horizons obliterated by incrustations of very fine calcite crystals, in other horizons slightly worn out. The foraminiferal assemblage contains numerous large Foraminifera over 1 cm. in diameter, large number of representatives of Miliolidae and Polymorphinidae, all with rather thick tests.

The facies of Calcaire de Mons in samples, sent kindly to the writer by Prof. R. MARLIÈRE, represents reef and detritic reef sediments of shallow, warm, littoral seas and is the next stage in the evolution of this part of the sea basin, commencing with the Middle Maastrichtian and approaching the Mediterranean facies.

The microfauna contained in Calcaire de Mons is completely different from that of the same age in Poland, where there was almost no influence of warm seas and where the climatic changes were minimal. A certain similarity with Poland is still to be found in the underlying Tuffeau de Ciply series, where the microfauna has not such a typical reef-like, warm and shallow character.

DANIAN STAGE IN LIMBURG REGION

(Text-plate IX)

Outcrops of the Upper Cretaceous and layers bordering upon the Tertiary occur along the Albert Canal in the Belgian Limburg and on the Geul River in the Dutch part of this region. They are particularly well developed in the neighbourhood of Vroenhoven, Belgium and in the Dutch quarry at Curfs. Layers, situated on the boundary between the Cretaceous and the Tertiary of the Belgian-Dutch Limburg, have recently been described in detail by MEIJER (1959). It was precisely in this region that the Maastrichtian horizon was established by DUMONT in 1849, the concept of the Maastrichtian of this author being layers of a loose, organo-detritic limestone, so-called »tuffeau«, containing fossils with *Belemnella casimirovensis* SKOŁOZ., *Scaphites (Hoploscaphites) constrictus* SOW., *Sphenodiscus binckhorsti* BÖHM and *Hemiaster prunella* (LAMARCK), which are index fossils of this horizon. Now, only the Upper Maastrichtian is recognized in these layers.

The tuffeau series of the Maastrichtian terminates in a locally hardened layer or, a really hard ground with an uneven surface, cut by numerous cavities and burrows, filled with younger sediments. At the Curfs quarry, they are represented by bright green glauconite sands, as well as by coarse-grained, loose, organo-detritic limestones of the »tuffeau« type, in which intercalations of coarse-grained quartz sands with Upper Maastrichtian fossil remains such as belemnites, *Thecidea papillata* and *Hemipneustes striato-radiatus*, reach a level of 1 m. above the surface of the hard ground. This series shows a distinct current sedimentation and is somewhat similar to the »siwak« series, occurring in central Poland. This similarity consists, among others, in the fact that, in the Netherlands, this series contains many hard calcareous nodules which are not sharply separated from the rock and occur in ever larger quantities, increasing towards the top, where they are embedded. *Crania brattenburgica* (SCHLOTHEIM), a brachiopod characteristic of the Danian, occurring in Denmark and Sweden, known as *Crania tuberculata* NILSSON, and — in Limburg — represented by the subspecies *Crania brattenburgica geulhemensis* (KRUYTZER & MEIJER, 1958), is numerous in the upper part of this series. Recently, a revision of

species belonging to the *Crania* genus has been made by ROSENKRANTZ (1964), who assigned *Crania tuberculata* NILSSON (syn. *brattenburgica* SCHLOTHEIM) to a new subgenus *Crania (Danocrania)* ROSENKRANTZ, 1964.

An analogous section is observed at Vroenhoven (on the Albert Canal). A series of loose, marly, organo-detritic sediments of the »tuffeau« type rests on the Upper Maastrichtian sediments, represented by the local *Md* horizon and terminating in a layer of hard ground. This series of the tuffeau contains a considerably larger admixture of glauconite than those on which it rests and is bright green in colour. It also contains several hard calcareous beds similar to those at Geulhem in the Curfs quarry. This series was called *Me* by HOFKER (1956, 1957) who considered it to be a passage layer between the *Md* tuffeau sediments, being — according to him — not of Danian but rather Paleocene age. MEIJER (1959) maintains that it is incorrect to denote this series by the symbol *Me*, since this implies that it belongs among the lower sediments marked by *Ma*, *Mb*, *Mc*, *Md*, these in turn implying that it belongs to the Maastrichtian. The calcareous beds, occurring within this series of tuffeau which is younger than the Maastrichtian, resemble to a considerable extent the typical thin layers of hard ground as they are perforated in many places and cut by burrows. Most fossils, concentrated on the surface of these hardened beds, are of Maastrichtian origin and are reworked, while they do not occur in general in the tuffeau itself.

The outcrops mentioned above, located both at Vroenhoven and the Curfs quarry, supplied MEIJER (1959) with a rich microfauna on the basis of which, particularly the pelagic foraminiferal assemblage of the tuffeau, this author identified the Danian age of these sediments. The occurrence of *Globigerina daubjergensis* BRONN., *G. compressa* PLUM., *G. pseudobulloides* PLUM. and *Globorotalia* ex gr. *compressa* was recorded in these sediments, while the *Globigerina triloculinoides* PLUM., usually accompanying this assemblage of the pelagic foraminifers, was absent.

The following assemblage of the benthonic foraminifers of the same layers was found by the present writer in samples collected with scientific assistance of Dr M. M. MEIJER: *Pararotalia tuberculifera* (RSS.), *Eponides toulmini* BROTZ., *Neoconorbina* sp., *Pulsiphonina prima* (PLUM.), *Osangularia lens* BROTZ. (= *O. cordieriana navarroana* (CUSHMAN)), *Gyroidina octocamerata* (CUSH. & HANNA), *Anomalina danica* (BROTZ.), *Cibicides ekblomi* BROTZ., *C. simplex* BROTZ., *C. voltzianus* (D'ORB.), *Robulus turbinatus* (PLUM.), *Bolivinoides polonica* POŻ. and *Sigmomorphina brotzeni* HOFKER. A similar assemblage was discovered by this same author at Geulhem, in the Curfs quarry: *Eponides toulmini* BROTZ., *Karreria fallax* RZEH., *Coleites reticulosus* PLUM., *Mississippina binckhorsti* (RSS.), *Gyroidina octocamerata* (CUSH. & HANNA), *Pararotalia tuberculifera* (RSS.), *Pulsiphonina prima* (PLUM.), *Alabamina midwayensis* BROTZ., *Anomalina danica* BROTZ., *Cibicides ekblomi* BROTZ., *Sigmomorphina brotzeni* HOFKER, *Robulus midwayensis* (PLUM.), *Frondicularia biformis* MARSS., *Globigerina daubjergensis* BRONN. and *Calcarina* sp.

The foraminiferal assemblage, mentioned above, is also well-known as belonging to both the Lower Paleocene (the Montian) and the Danian, since the microfauna of these two geological stages is very similar. However, the *Globigerina daubjergensis* and *Bolivinoides polonica*, abundantly represented, are well-known primarily as belonging to the Danian. There are only a few specimens of these species that pass to the Montian. On the other hand, in the assemblage, mentioned above, lack these Paleocene elements which were never recorded in the Danian of Poland, Sweden, Denmark and the Crimea. The age of the post-Maastrichtian sediments at Vroenhoven and Curfs seems, therefore, to be correctly estimated by MEIJER (1959) as Danian. HOFKER's interpretation is, however, different (1957). Numbering the tuffeau (*Ma-Md*) layers, together with the hard ground layer in which they terminate, to the Danian, HOFKER classed

the upper-lying tuffeau layers among the Paleocene sediments. An impoverished fauna of the Maastrichtian stage, as well as various elements undergoing evolution to the Paleocene fauna, were found by him in these layers. This is based on the »true orthogenesis«-theory of the evolution of the foraminifers, related by HOFKER to the *Globigerina daubjergensis* BRONN., but — according to BERGGREN (1962) — belonging to the *Rugoglobigerina macrocephala* BRONN. in Maastrichtian.

The Danian age of the post-Maastrichtian beds in Limburg was recently confirmed by WIENBERG RASMUSSEN (1962) on the basis of the echinoderm remnants. A close affinity of the post-Maastrichtian tuffeau to the Danian sediments of Denmark was proved by this author whose studies on the Crinoidea and Asteroidea remnants have indicated that almost all species identified by him occurred both in Limburg's *Me* and in the Danian of Denmark. The most important are columnals of the *Bourgeticrinus danicus*, a species restricted to the Danian only, *Democrinus maximus*, *Metopaster (Metopaster) carinatus*, *M. kagstrupensis*, *Stauranderaster miliaspenceri*, the latter characteristic of the Lower Danian zone, *Valettaster granulatus* and some other species. MEIJER's stratigraphical conclusions (1959) are fully confirmed by the presence of the *Tylocidaris bruennichi* RAVN, an index fossil of the Middle Danian of Denmark, in the post-Maastrichtian sediments, occurring at the Albert Canal. Interesting data were supplied by DEROO (1959) who discovered the presence of an analogous ostracod assemblage in the post-Maastrichtian layers and in the series of the Tuffeau de Ciply.

The Danian tuffeau layers, occurring in the Belgian-Dutch Limburg, are much more calcareous and calcareous-detritic as compared to sediments of the same stage, recorded in the Polish Lowland. As regards the lithological aspect, they show some similarity only to the Montian sediments of the Pamiętowo boring (northern Poland), developed in the form of loose, organo-detritic, calcareous sediments approximating in quality the tuffeau type.

Most probably, the hard ground of the Upper Maastrichtian in Limburg is of the same age as the hard ground at Góra Puławska and Żyrzyn, Poland (recorded in borings). In Limburg, there is no equivalent of the Żyrzyn layers, that is of a sediment series younger than the hard ground and undoubtedly still belonging to the Maastrichtian. The Danian layers in Limburg are certainly strongly condensed since they are not only much thinner than in the type region, that is Denmark and Sweden, but also they represent a very condensed series even as compared with the Crimea, Georgia and Poland. At any rate, the occurrence of the Middle Danian is indicated by the presence of the *Crania brattenburgica*[2] and the *Tylocidaris bruennichi*.

DANIAN AND MONTIAN OF THE CRIMEA

(Text-plates VIII, IX; Table 4)

The Crimea and the Caucasus are intermediate areas between platform or epicontinental and geosynclinal formations of many series. The Upper Cretaceous in the Crimea is entirely platformic, while in the Caucasus it is only partially so. Particularly interesting are the Upper Cretaceous formations of the western or little Caucasus where, in several places, the platformic and geosynclinal facies overlap.

[2] *Crania (Danocrania) geulhemensis* KRUYTZER & MEIJER — see ROSENKRANTZ, 1964, p. 515.

Correlation

S. Crimea — Moskvin, 1960; Morozova 1959 1960, 1961

Index species

Acarinina concotruncata (Subb.)
Nummulites sp.sp.

Isaster abkhasicus (Schwetz)
Echinocorys dioscuriae (Schwetz)
Cibicides favorabilis Vas.

Protobrissus indolensis Posl.
Galeaster dagestanensis Posl
Acarinina praecursoria Moroz
Globigerina varianta Subb.
Loxostomum applinae (Plum.)
Acarinina angulata (White)
Ceratobulimina tuberculata Brotz.
Planularia discus (Brotz.)

Protobrissus tercensis (Cott.)
Globigerina daubjergensis Bronn.
Acarinina indolensis Moroz.

Echinocorys obliquus Ravn.
Echinocorys sulcatus Goldf.
Echinocorys pyrenaicus Seun.
Globigerina triloculinoides Plum.
Globigerina pseudobulloides Plum.
Globigerina daubjergensis Bronn.

Echinocorys sulcatus Goldf.
Protobrissus akkajensis (Web.)
Globigerina quadrata White
Globigerina compressa Plum.
Globigerina eobulloides Moroz.

Discoscaphites constrictus Sow.
Belemnella archangielskii Naid.
Pseudotextularia varians Rzeh.
Bolivina incrassata crassa Vas.
Rugoglobigerina sp.

Cranial tuberculata Schloth.
Hercoglossa danica

Indol region

Thanetian
Upper Montian
Lower Montian
uppermost Danian ?
Danian — Upper
Danian — Lower
Upper Maastrichtian

North and Central Poland

Poland — Pożaryski & Pożaryska, 1960; Brotzen & Pożaryska 1957, 1960

Index species

Angulogerina muralis (Terquem)
Globorotalia acuta Toulmin

Globorotalia angulata (White)
Globigerina kozłowskii Brotz. & Poz

Ceratobulimina tuberculata Brotz
Lamarckina rugulosa Plum
Planularia pulavensis Poz
Planularia bzurae Poz.
Globigerina varianta Subb
Loxostomum applinae Plum

Globigerina daubjergensis Bronn
Globigerina pseudobulloides Plum
Globigerina triloculinoides Plum.
Planularia pulavensis Poż.
Planularia discus (Brotz.)
Bolivinoides vistulae Poż.

Discoscaphites constrictus Sow.
Belemnella casimirovensis Skol
Neoflabellina reticulata (Rss.)
Bolivina incrassata Rss.
Rugoglobigerina rugosa (Plum.)

- *Lithothamnian limestone*
- *aleurolite siltstone*
- *gaise*
- *hard limestone*
- *organic detritic limest. tuffeau*
- *limestone with flints*
- *sandy marl*
- *hard ground*
- *phosphatic nodules*
- *siliceous limest. „opoka"*

CORRELATION OF DANO-MONTIAN SECTIONS IN SOUTH CRIMEA AND POLAND

A transformation of the geosynclinal into the epicontinental facies on the boundary between the Jurassic and Cretaceous can be observed in the Crimea. A considerable analogy exists both in the lithology and in the character of the fauna of the entire Upper Cretaceous (including the Danian and the Montian) of the Crimea and of Poland, north of the Carpathian Mountains. These beds occur in the south-western part of the Crimea where, in the Bakchisaray region (near Simferopol), they are particularly well exposed. They have been described by MURATOV (1960), MOSKVIN (1959, 1960) and others. The foraminiferal stratigraphy was established by ŠUCKAJA (1958), MASLAKOVA (1959) and MOROZOVA (1959, 1960, 1961).

The Upper Cretaceous and lowermost Paleogene beds in the south-west Crimea, Bakchisaray region, are exposed between the so-called first and second ridge, forming a kind of cuesta. As compared to Poland, they represent a more condensed series, with more hiatuses, although without any distinct influence of the nearby land. In spite of a general similarity, the differences, consisting in the generally greater detritic material content of Polish sediments, should be interpreted as an absence of a land area, adjoining the Crimea, beginning from the Upper Cretaceous (see Text-pl. I). In Poland, such land existed permanently on the territories of the Sudeten Mountains, Upper Silesia and Holy Cross Mountains (the so-called Middle European Land).

The second ridge consists of deposits ranging from the Cretaceous to Tertiary, i.e. from the Maastrichtian, Danian, Paleocene and Eocene series. Among these deposits, the Maastrichtian is represented by soft marls and marly sandstones, 70-80 m. thick. It is well characterized by an index macrofauna (known in other Maastrichtian localities in Europe), comprising *Scaphites (Hoploscaphites) constrictus*, *Pecten acuteplicatus* and *Belemnella archangielskii (=arkhangelskii)*, the latter being an equivalent of the *Belemnella casimirovensis* occurring in Poland.

The foraminiferal assemblage occurring in the Maastrichtian of the Crimea, cited by MOROZOVA (1960), is very similar to the well-known assemblage found in the beds of the same age in the North-European province. In the uppermost parts of the Upper Maastrichtian of the Crimea, one can find a series of marly sandstones with a thin, hardened layer cut by numerous burrows with the character of a typical hard ground. By its appearance and the development of the burrows, this thin layer is fairly similar to that (described by the present author in 1952), occurring at Bochotnica and Nasiłow near Puławy (central Poland), where it is developed in the »opoka« rocks of the same age. In the Crimea, a series of Danian beds, beginning with glauconite sandstone with phosphatic nodules, rests on a hard ground layer. Just above the surface of the hard ground, relatively numerous belemnite rostra occur in this layer. This indicates a great analogy with facts observed on the middle Vistula River in Poland. The glauconite sediment, containing at its base reworked belemnites, is undoubtedly of Danian, and not of Maastrichtian age, since, both in the Crimea and Poland, it contains an assemblage of foraminifers younger than those of the Upper Maastrichtian.

The Danian sea in the Crimea constitutes an insignificant extension as compared to the Maastrichtian sea. It was a very shallow, shelf sea. The Danian deposits in the Crimea consist mostly of limestones which are sandy at the base and — towards the top — contain irregularly shaped flints, distributed according to a certain rhythm, as well as intercalations of the »tuffeau« type detritic limestones with numerous bryozoan pockets. In our opinion, they correspond lithologically to the typical »tuffeau« rocks of the Canal d'Albert, Limburg, Belgium and are particularly similar to the *Me* bed, outcropping near Vroenhoven. In the Crimea, this series passes in a continuous manner into Montian sediments, which lithologically do not significantly differ from the Danian limestones, the detritic limestones predominating to a somewhat

higher degree over compact limestones. In the top layers of the Montian, the Crimean limestones become harder, conglomeratic and contain numerous pelecypods and gastropods, preserved in the form of moulds and casts. These limestones greatly resemble the Bulgarian beds of the same age, occurring in the neighbourhood of Plevna. On the other hand, they pronouncedly differ from the Danian and Montian sediments of central Poland, where they can be observed in the form of a monotonous series of green-gray, calcareous »gaizes« with limestone intercalations. The existence of the »tuffeau« type rocks was recorded in this series only in the boring at Pamiętowo in northern Poland. In Poland, the passage from the Danian to the Montian is, in this series, also macroscopically invisible and, therefore, the concept of the Dano-Montian is applied to it.

The process of the Danian and the Montian sedimentations was not uniform. There were cyclic changes. In the majority of the south Crimean outcrops and particularly in the Indol River basin, marly layers are intercalated with much harder limestone beds. The thickness of the limestone and the marly layers occurring between them amounts to some dozen centimetres or so. This rhythmic sedimentation is characteristic of most Danian and Montian beds in Europe, from the Crimea through Poland and Denmark to Belgium and the Netherlands (W. & K. POŻARYSKI, 1959).

The Danian of the S Crimea is 40 m. thick, while the Montian of this peninsula — only 20 m.

The passage from the Danian to the Montian in the Crimea is fully continuous and macroscopically invisible. On the basis of this fact Russian authors write about a Dano-Montian series located between two distinct levels of hard ground, i.e. the Upper Maastrichtian and Upper Montian, the latter overlaid in turn in an unconformable manner by the glauconitic Thanetian sediments. There exists a considerable analogy to Poland where it is also easier to discuss the Dano-Montian series than to distinguish the Danian and the Montian separately.

In the Crimea, the Dano-Montian series is divided on the basis of the macrofauna, mostly of echinids, on the one hand, and of microfauna, i.e. foraminifers, on the other. These faunas enabled the geologists in Crimea to divide the Danian from the Montian and to distinguish two horizons in each. A certain diversity of opinion exists between Russian authors as regards the boundary between the Danian and the Montian. The index nautiloid, identified as *Hercoglossa danica*, thus far never met with in Poland, occurs in the Danian of the Crimea. In the Upper Danian of the Crimea, *Crania (Ancistrocrania) tuberculata* appears which also occurs in overlying layers, considered by some authors as belonging to the uppermost Danian (MOROZOVA, 1959, 1960) and — by others — even to the Montian (MOSKVIN, 1960; ŠUCKAJA, 1958, 1960). In Poland, *Crania tuberculata* sensu lato is known from several borings at Boryszew, Sochaczew and Płock. At all these places, it was recorded in the lowermost Montian and not in the Danian as in the case of the Crimea. According to ROSENKRANTZ (1964), these cranias, found in Poland, belong to the *Crania (Danocrania) polonica* RKZ. and are very closely related to *Crania tuberculata* NILS. sensu lato, but not to *Crania tuberculata* sensu stricto.

The occurrence of the echinid *Protobrissus akkajensis* and an assemblage of tiny, smooth-walled pelagic foraminifers, the *Globigerina eobulloides*, *G. quadrata* and *G. compressa* is characteristic of the Lower Danian in the Crimea, although, generally speaking, foraminifers are rather scarce in the Danian of the south-western part of this country. *Echinocorys obliquus*, *E. sulcatus*, *E. pyrenaicus* and an assemblage of the spinulose, sculptured globigerinids, *Globigerina triloculinoides*, *G. pseudobulloides* and *G. daubjergensis* are characteristic of the Upper Danian of the Crimea. The latter globigerinid also occurs in the lowermost Montian in Poland, as well as in the Crimea where it is to be found in the uppermost, debatable level of the Upper Danian or, possibly, in the lowermost horizon of the Montian.

This horizon, containing *Protobrissus tercensis*, is considered by MOSKVIN to belong to the Montian. A layer of minute phosphatic nodules, which — according to MOROZOVA — separates the Danian from the Montian, is — in MOSKVIN's opinion — located in the Montian series (see Text-plate VIII). In a washed sample, sent kindly by Professor M. M. MOSKVIN from Kurskoje (Indol region) from the Upper Danian (local horizon 35—38), the present writer has recorded following species: *Ataxophragmoides frankei, Bulimina ovata, Globigerina daubjergensis, Cibicides commatus, C. proprius, Anomalina praeacuta, A. danica.* In another sample, sent kindly by the same author, from Kurskoje, from the uppermost Danian debatable layer (horizon 39—42), the present writer has recorded: *Bulimina ovata, Pseudoparrella limburgensis, Cibicides succedens, Anomalina acuta.* In the horizon 43, belonging without any doubt to the Montian, the present writer recorded: *Bulimina paleocenica, Alabamina midwayensis, Osangularia cordieriana navarroana (= Parrella lens), Nonionella troostae troostae, Eponides frankei, Globorotalia* sp., *Anomalina danica.*

Thus far, echinids were not found in the undoubted Danian of Poland, the reason for this being probably the fact that there are no true surface outcrops of it. It makes up a »subsurface formation«. At Bochotnica and Nasiłów, the Danian is known only in the form of remnants, condensed to 0·3-0·4 m. of thickness. Echinids, which are found there, can derive from the Maastrichtian, as well as from the Montian resting on it. Pelagic foraminifers, smooth-walled globigerinids, have not been recorded in the Polish Danian. Only the spinulose, sculptured foraminifers of the species analogous to those of the Crimea occur there. Maybe, it can be concluded from this fact that in Poland there is no lower horizon of the Danian, which is quite possible. On the other hand, an absence of the *Crania tuberculata* s.l. from the Danian and its presence in the lowermost Montian of Poland might indicate a certain affinity, occurring between the lowermost Montian layers in Poland and the uppermost Danian in the Crimea. The occurrence of the first representatives of the genus *Acarinina* in the Upper Danian of the Crimea could also support this supposition. This concerns the following species: *Acarinina praecursoria, A. angulata* and *A. indolensis* (MOROZOVA, 1960) which are characteristic of even such a late series as Paleocene. The results of the investigations of ŠUCKAJA (1958, 1960), according to whom, an assemblage of foraminifers, contained in the uppermost Danian layer in the Crimea, belongs rather to the Montian, seem also to prove this hypothesis. An assemblage of foraminifers, resembling that from Klagshamn, Sweden (BROTZEN, 1948), occurs there only in higher Montian limestones.

A correlation between the Dano-Montian sections of Poland and the Crimea can thus be based on a striking analogy in the development of the uppermost layer of the Maastrichtian, i.e. the so-called hard ground and quite analogous macro- and microfauna contained in it, and on a proper correlation of the Montian layers.

DANIAN AND LOWER PALEOCENE IN GEORGIA (U. S. S. R.)

(Text-plate IX; Table 4)

Although the Georgia (U. S. S. R.) is situated between the Great and Little Caucasus, that is in the area of the Alpine geosyncline, the present writer has included the characteristic of the Danian and Paleocene sediments of this country in the present work. Both these mountain ranges are marked by their typically geosynclinal development and the Georgian crustal block, located between them, is distinguished by facies which considerably deviate from the geosynclinal, approaching the platformic character. On the area of this crustal block the Mesozoic

is insignificant in thickness. Particular horizons are some scores of metres in thickness, while in the surrounding, typical geosyncline — several thousand metres. Layers are mostly flat, sometimes forming only slightly marked folds with many gaps in sedimentation and almost no traces of metamorphism. These are typically passage sediments between the geosynclinal and platformic type.

The Danian beds in Georgia are well developed and widely spread in all tectonic units, although partially eroded during the Paleocene transgression. Everywhere, they rest — as conformable layers — on the Maastrichtian beds and are transgressively covered, mostly unconformably, by the Paleocene sediments.

The Upper Cretaceous, Danian and Paleocene sediments were investigated and described by TZAGARELI (1954), I. & M. KAČARAVA (1960) and others.

The Upper Maastrichtian is mostly represented by limestones which contain, like everywhere else in Europe, ammonites, with *Scaphites (Hoploscaphites) constrictus* SOV. predominating and *Inoceramus balticus* BÖHM, *Echinocorys ovatus* LESKE, etc. A series of white limestones rests on the Maastrichtian. These limestones are without ammonites and inoceramids, but contain the index fossils: *Hercoglossa danica* SCHL., *Crania brattenburgensis* SCHL. and a very rich fauna of echinids such as the *Micraster (Protobrissus) akkajensis* WEB., *Echinocorys sulcatus* GOLDF., *E. pyrenaicus* SEUN., *Coraster vilanovae* COTT., *C. munieri* SEUN., *C. sphaericus* SEUN., *C. frechi* BÖHM and others (TZAGARELI, 1954).

Of the microfauna, *Guembelina globulosa* EHR., *Pseudotextularia elegans* RZEH., *P. varians* RZEH., *Globotruncana arca* CUSH., *G. contusa* CUSH., *G. conica* WHITE, *G. stuarti* LAPP and others (I. & M. KAČARAVA, 1960) occur in the beds of the Upper Maastrichtian. The following assemblage of the foraminifers has been recorded by the same authors in the Lower Danian: *Chiloguembelina midwayensis* CUSH., *Gyroidina octocamerata* CUSH. & HANNA, *Eponides frankei* BROTZ., *Globigerina triloculinoides* PLUM., *G. varianta* SUBB., *G. pseudobulloides* PLUM., *G. daubjergensis* BRONN., *G. compressa* PLUM., *Globorotalia quasimembranacea* M. KATSCH., *G. edita* SUBB., *G. imitata* SUBB., *G. inconstans* SUBB. Another foraminiferal assemblage of which the most important from the stratigraphical standpoint are *Globorotalia membranacea*, *G. conicotruncata* SUBB., *G. conicotruncata praepentacamerata* SCHUZ., has been recorded in the upper horizon of the Danian.

The Danian of Georgia consists, therefore, of two horizons: the Lower Danian marked by an assemblage of small globigerinids and globorotalids, first occurring here, and the Upper Danian with *Globorotalia conicotruncata* SUBB. (I. & M. KAČARAVA, 1960) as an index foraminifer of this stage.

The thickness of the Danian in Georgia varies considerably fluctuating between 20-30 and 100 m., an average figure being 40-50 m. The latter does not of course concern the flysch facies. On the basis of the close affinity between the Upper Maastrichtian and the Danian fauna, an analogous lithological development and a comparable deposition of strata, the view is accepted that the Danian in Georgia still belongs to the Cretaceous system.

Gray-green marls and calcareous clays, corresponding to the Paleocene, rest on white limestones of the Danian. An assemblage of the following foraminifers was found there (I. & M. KAČARAVA, 1960): *Globigerina eocaenica* TERQ., *G. pseudoeocaena* SUBB., *Acarinina acarinata* SUBB., *A. triplex* SUBB., *Globigerina linaperta* FINLAY, *Globorotalia acuta* TOUL., *G. (Truncorotalia) marginodentata* SUBB., *G. (Truncorotalia) crassata* CUSH. The first appearance of foraminifers of the genus *Truncorotalia*, characteristic of the Paleocene of Georgia and of the Upper Paleocene of other continents, is a distinguishing feature of this horizon. Besides, the first discocyclines and nummulites such as *Nummulites praecursor* DE LA HARPE and *N. per-*

notus SCHAUB., occur at the beginning of the Paleocene in Georgia with Ypresian sediments, containing *Nummulites planulatus* LAM., resting on them.

According to I. and M. KAČARAVA (1960), there is a considerable faunistic affinity between the Danian of Georgia and that of the Aquitanian Basin in France. In the Aquitanian Basin, however, the Danian is transgressively deposited on the Maastrichtian. The Danian of Georgia is, generally speaking, rather regressive in character. This is particularly marked in eastern parts of this country where the horizon of lithographical limestones contains fresh water fauna, constituting a stratigraphical equivalent of the regressive marine Danian of Georgia's western regions. Already a typical Tertiary fauna, represented by species common to the Montian of Belgium (I. & M. KAČARAVA, 1960) occurs in the upper layer of this horizon. The fauna of echinids occurring here does not contain forms characteristic of the Danian of Denmark which seems to prove the shallowness of this sea on the territory of the Georgian crustal block.

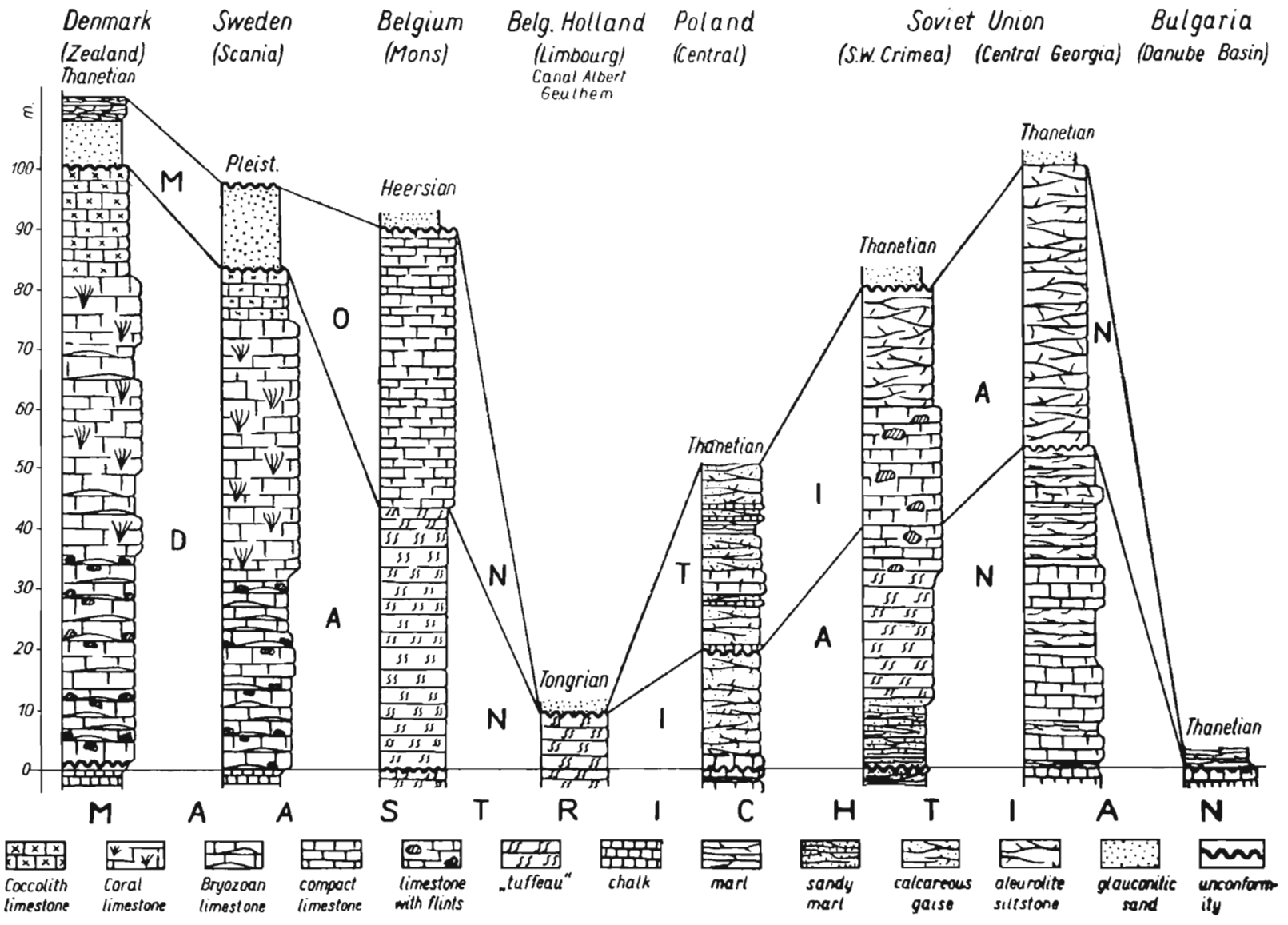
Thus, it can be said that the Danian of Georgia is marked, in respect to foraminifers, by the absence of the *Globotruncana* and by a considerable number of representatives of small species of *Globigerina* and *Globorotalia*. The Paleocene is characterized by the first appearance of truncorotalias, nummulites and discocyclines.

The stratigraphical correlation of these horizons with analogous ones in the Aquitanian Basin, Switzerland, Italy and other countries of the Mediterranean province did not present any major difficulties to Georgian authors. A comparison with typical sections of Denmark, Sweden and even the Crimea is, however, much more difficult. The analogy to the conditions observed in Denmark and Sweden is based, by these authors, primarily on the regressive chracter of Danian beds in Scandinavia and the transgressive character — of the Paleocene. In their opinion, the Cretaceous sedimentary cycle is ended by the Danian sediments and a new, Eocene sedimentary cycle is begun by the Paleocene sediments.

A comparison of the Danian and Paleocene of Georgia with the Danian and Montian of Poland is difficult. Although these beds in Georgia are not typically geosynclinal, they constitute a facies transitory to the platformic one, containing several elements of the Alpine-Mediterranean zone. This applies to both the echinids and foraminifers, the latter small, as well as large, such as *Nummulites* and *Discocyclina* which are absent from the epicontinental facies of central Europe. The series of the Danian and Paleocene in Polish Lowland are strongly reduced, here and there even occurring in a remnant form and are not represented by purely calcareous sediments as is the case of the Danian in Georgia. For the above reasons, a direct comparison between these series in Georgia and Poland is almost impossible, while it may be possible by an analogy to the Crimea.

The Danian of Georgia approaches in character to the Danian of the southern Crimea. The Upper-Cretaceous sea of Georgia was situated at the meeting point of the three zoogeographical provinces (TZAGARELI, 1954), that is Middle and South European and South Asian. This is why a mixed fauna, however closely related to the Crimean forms, is to be found in this sea. Consequently, it was possible to establish on this territory the Crimean-Caucasian province. From the lithological and faunistic standpoints, these countries are closely related. The Danian of both is expressed by calcareous facies with considerably related fauna of echinids, e.g. *Echinocorys pyrenaicus* SEUN. and *E. sulcatus* GOLDF., as well as with a common, specific form of the Crimean Danian, *Micraster (Protobrissus) akkajensis* (WEB.). In addition, there are such common forms as the *Hercoglossa danica* and *Crania tuberculata* NILS. (*Crania brattenburgensis* SCHL.). Only an assemblage of pelagic foraminifers is common for the Danian of both Poland and the Crimea, i.e. *Globigerina pseudobulloides*, *G. triloculinoides* and *G. compressa*. *Globorotalia angulata* (WHITE) of this assemblage is known in the Crimea and Poland to occur only in the

TEXT-PLATE IX



CORRELATION OF DANIAN AND MONTIAN DEPOSITS IN CENTRAL EUROPE

Montian and, moreover, not in its lowermost stage. The same concerns *Globorotalia conicotruncata* (SUBB.), an index species of the Thanetian in the Crimea which, in Georgia, was found already in the Upper Danian.

On the basis of the above considerations the conclusion can be drawn that the entire stratigraphical sequence of the Danian and Paleocene of the Georgian massif is placed lower as compared with the Crimea and Middle European Basin, therefore, also with Poland. Thus, it seems that the layers containing the *Nummulites* and *Discocyclina* should be numbered not with the Lower, but Upper Paleocene, while those with *Globorotalia angulata* and *G. conicotruncata* — belong to the Lower Paleocene and not to Upper Danian, because these two important species of *Globorotalia* have never been recorded in such low layers and the appearance of *Globorotalia* is generally considered a symptom of the beginning of the Paleocene. The stratigraphical correlation (Text-plate IX and Table 4) is based on current views and principles prevailing in Georgia and Crimea. However, this should be subjected to discussion. In Georgia, the layers containing *Globotruncana* adjoin those containing *Globorotalia*. It can be concluded even on the basis of this simple fact that there is either no Danian at all, or it is considerably reduced and that the entire horizon of the Upper Danian is missing. Limestones, containing the fauna of small, smooth-walled *Globigerina*, already without *Globotruncana* but, on the other hand, still without the *Globorotalia*, should be considered as Lower Danian forms. The assemblage of small *Globigerina* is accompanied by *Hercoglossa danica* and by an assemblage of Danian echinids with the index corasters. The layers containing the representatives of the genera *Globorotalia* and *Acarinina* should be assigned to the Lower Paleocene representatives, and those with *Nummulites* and other larger foraminifers — to the Upper Paleocene.

The above conclusions seem to comply with the stratigraphy established by ŠUCKAJA (1956) for Daghestan, central Ciscaucasia and western Turkmenistan. According to this author, the Danian in the calcareous facies is marked there, as elsewhere, by the nautiloid *Hercoglossa danica* and by an assemblage of small pelagic foraminifers of the genus *Globigerina*. Higher, in the layer, containing the *Protobrissus tercensis*, the first *Globorotalia* appear such as *Globorotalia angulata*, *Acarinina inconstans*, *A. indolensis* which correspond to the Lower Paleocene. Still higher, that is already in the Upper Paleocene, a rich assemblage of *Acarinina* occurs in the following succession: *Acarinina conicotruncata*, *A. tadjicistanensis*, *A. subsphaerica* and *A. acarinata*. Besides, *Globorotalia angulata* continues to appear in this layer. *Acarinina conicotruncata* occurs in the Crimea, as well as in Ciscaucasia, Daghestan and Turkmenistan in much higher layers — in the Upper Paleocene, while in Georgia its occurrence is already recorded in the Upper Danian. It seems, therefore, that this might be considered an additional reason for numbering in Georgia the layers with *Nummulites* and *Discocyclina* with the Upper Paleocene and those at present considered as part of the Upper Danian — with the Lower Paleocene.

A small number of foraminifers of the Danian and many foraminifers of the Paleocene were obtained from samples of the Danian and Paleocene collected in 1962 by the author of the present paper with scientific assistance of Mrs M. KAČARAVA from the outcrops in the neighbourhood of Mikhaylovka village, located within the region of the Somkhitskaya »glyba«, south-west of Tbilisi (Tiflis), Georgia.

The Lower Danian: *Stensioeina caucasica*, *Globigerina varianta*, *Anomalina praeacuta*, *G. compressa*.

The Upper Danian: *Stensioeina caucasica*, *Globigerina linaperta*, *G. compressa*, *Globorotalia conicotruncata*, *Allomorphina* sp., *Neoflabellina reticulata* (probably reworked), *Robulus pseudo-mamilligerus*, *R. rancocasensis*, *R. degolyeri*, *Planularia discus*, *Hoeglundina scalaris*,

Vaginulinopsis longiforma, *Bulimina ovata*, *Karreria fallax*, *Lamarckina rugulosa*, *Pulsiphonina prima*, *Anomalina danica*, *Cibicides succedens*, *C. proprius*, *C.* cf. *carinatus*, *Globigerina triloculinoides* and others.

In view of the fact that the typical Paleocene specimens of *Robulus*, *Cibicides succedens* and, primarily, *Lamarckina rugulosa*, species unknown to occur anywhere in the Danian, were found in these layers, their Paleocene age is for the present author indubitable. On the other hand, the doubts, expressed above, as to the stratigraphical position of these layers are confirmed by the presence of *Globigerina linaperta* and *Globorotalia conicotruncata* in the Upper Danian. The question also arises as to whether it would be best to put these layers higher in the stratigraphy and consider them younger.

THE SO-CALLED DANIAN IN NORTHERN BULGARIA, DANUBE BASIN

(Text-plate IX; Table 4)

The Danian series in Bulgaria were investigated and described by BONČEV (1936), TZANKOV (1940) and others. They occur, among others, in the central part of northern Bulgaria on the so-called north Bulgarian plateau, extending between the Stara Planica mountain range, latitudinal in direction, and the Danube River. The Danian beds outcrop there in the neighbourhood of Plevna and Somovit where they reach 45 m. in thickness. They are located in a synclinal depression framed by the Markov anticline in the south and by the faulted Danube Valley in the north. The syncline, mentioned above, is filled with the Upper Maastrichtian calcareous-marly sediments with *Hemipneustes striato-radiatus* and *Coraster vilanovae*. They contain black and dark-brown, stratified flints with no cherts at all.

A boundary between the Maastrichtian and higher beds is in northern Bulgaria quite different from that in Poland and other north European countries. In Bulgaria, there is no hard ground in the uppermost part of the Maastrichtian. It is true, there are cavities or shallow depressions but they are extensive, gently outlined, with an amplitude fluctuating within limits of 0·5 and 1·0 m. and of an unquestionably erosional character. The surface of these extensive, undulating depressions is covered with a thin layer of weathering clay called »terra rossa« or, here and there, with a sandy kaolin (TZANKOV, 1940).

Very hard, strongly recrystallized limestones with a rich fauna of pelecypods and gastropods, their shells mostly dissolved, which occur in the neighbourhood of Plevna, are described by Bulgarian authors as the Danian. These limestones form a sort of »lumachelles«. Together with equally hard but lower situated Maastrichtian limestones they are used as a highway gravel. In the vicinity of Somovit, the beds described as a possible Danian (TZANKOV, 1940) lie on Upper Maastrichtian sediments developed in the form of pure limestones with a high $CaCO_3$ content (98 %) exploited as a raw material for the production of the cement. In 1951, a series of sediments above the Maastrichtian was investigated by the author of the present paper at Somovit, with scientific assistance of Professor V. TZANKOV. These sediments consisted of sandy marls with flints and of typical, that is light, porous, rich in silica »gaizes« similar to those occurring in the Paris Basin and in Belgium, which were described by L. CAYEUX (1929). Small pockets of soft chalk can also be observed here and there. These rocks, identified by Bulgarian authors as calcareous and — in some places — sandy marls and glauconite sandy limestones, contain neither belemnites nor ammonites. On the other hand, there occur the

following fossils which prove the Danian age of these beds (TZANKOV, 1940): *Bourgeticrinus danicus* NIELSEN, *Micraster tercensis* COTTEAU, *Crania tuberculata* (NILS.), *Terebratula mobergi* LUNG., *Spondylus danicus* RAVN, *Hercoglossa serpentina*, *Nautilus bellerophon* LUNDGR., *Discocyclina seunesi* DOUVILLÉ (very numerous).

Crania tuberculata described by TZANKOV (1940) belongs to subgenus *Danocrania* ROSENKRANTZ, 1964, as was stated by ROSENKRANTZ (1964). *Crania (Danocrania) tuberculata* TZANKOV presumably represents a new species, according to Prof. ROSENKRANTZ's personal communication. The character of its outer sculpture is in accordance with the sculpture found in the Paleocene (Thanetian) and Eocene? species from Austria and Bavaria: C. *(Danocrania) austriaca* TRAUB and *C. (Danocrania) kressenbergensis* GÜMBEL. This conclusion is in a quite accordance with the result of the present writer, obtained by means of Foraminifera.

The pelagic foraminifers, occurring in this assemblage (identified by the present writer) indicate the Upper Paleocene and not Danian age of the series resting on the Upper Maastrichtian limestones at Somovit. These are the following species: *Globorotalia aequa* CUSHMAN & RENZ, *G. velascoensis* (CUSHMAN), *G. angulata* (WHITE), *G. pseudomenardii* BOLLI, *Acarinina acarinata* SUBBOTINA, *Globigerina linaperta* FINLAY, *Asterigerina* sp., *Uvigerina* sp., *Spiroplectammina* sp., *Coleites reticulosus* PLUMMER, *Cibicides commatus* VASILENKO, *Pseudopolymorphina frondea* (CUSHMAN), *Ataxophragmoides frankei* BROTZEN, *Angulogerina cuneata* BROTZEN, *Eponides toulmini* BROTZEN, *Anomalina danica* BROTZEN, *Pullenia americana* CUSHMAN, *Alabamina midwayensis* BROTZEN, *Osangularia* sp., *Pulsiphonina* sp.

It is particularly an assemblage of species belonging to the genus *Globorotalia*, found in these beds, that pronouncedly points out the Upper Paleocene and not Danian age of these strata. This assemblage is well known primarily in America (Trinidad), that is in the Lower Lizard Springs Formation, corresponding to the Upper Paleocene (LOEBLICH et al., 1957). A younger age than Danian is also indicated by the presence of *Acarinina acarinata*, *Globigerina linaperta*, *Asterigerina* sp. and also of *Discocyclina seunesi* itself.

In samples from the »Danian« of Somovit on the Danube River, SZCZECHURA (1965) found a few specimens of *Echinocythereis aragonensis* OERTLI, 1960, described from the Lutetian of Spain. This species occurs in Lower Paleocene of Poland and was also found by SZCZECHURA in the Selandian of Denmark, from Hvalløse (Jutland peninsula).

In addition, it also seems indubitable that the Bulgarian sediments, containing the assemblage of foraminifers, listed above, represent a geosynclinal facies of the Tethys Ocean and not epicontinental north European one, as suggested by TZANKOV (1940), because they show fundamental differences as compared to the foraminiferal biofacies of the north European province.

BELMUSTAKOV has recently (1961-1963) discussed the problem of Lower Tertiary stratigraphy in northern Bulgaria, however he referred to an area lying further east than the one under discussion in this paper and he has not as yet published any stratigraphy on Somovit and Plevna area (Danube region).

GENERAL CONCLUSIONS

(Text-plates I, IX; Table 4)

On the palaeogeographical map (Text-plate I) the Lower Paleocene sea and perhaps even the Danian sea of central Poland was connected through the western Ukraine (Lwów region) with the alpine geosyncline sea. Proof of this is the presence of sediments of that age in the northern Transcarpathians of Poland. A comparison of the microfauna of the lowermost Tertiary in Polish Lowland with that of the Carpathians has not yet been undertaken. On the other hand,

on the base of the literature, there is a striking similarity between the Lower Paleocene microfaunal assemblages of Poland and Austria, however some Austrian papers refer to them as Danian (SCHMID, 1962). In addition to *Loxostomum applinae* (PLUMMER) and *Robulus pseudomamilligerus* (PLUMMER) described by SCHMID (1962), the presence of *Lamarckina rugulosa* PLUMMER, *Ceratobulimina tuberculata* BROTZEN, *Pyramidina crassa* BROTZEN and *Robulus klagshamnensis* BROTZEN, has also been stated by the present writer in samples from Austria.

The above mentioned species have also been described from the Lower Paleocene of Poland (BROTZEN & POŻARYSKA, 1957, POŻARYSKA, 1964, and in the present paper). Some of them, e.g. *Lamarckina rugulosa*, are not known so far in Swedish Paleocene. This is an evidence that *L. rugulosa* migrated to Poland from the south, by way of the western Ukraine.

This narrow Lower Paleocene sea, and probably the Danian too, was connected eastwards across the area of south Lithuania with the Donetz Basin (Text-plate I). A proof of this is the Lower Paleocene microfauna in the Donetz Basin, cited by VASILENKO (1950) and in south Lithuania by GRIGELIS (1960), the same as that described by BROTZEN (1948) from Sweden and by the present writer from Poland (1964 and in the present paper).

The most striking is the similarity between the Danian and Lower Paleocene microfaunal assemblages of Poland and Sweden; about 80 per cent of species are in common. This applies both to the most common species occurring in Danian and Lower Paleocene, as well as to the index ones for the Lower Paleocene.

A Danian and Lower Paleocene sea formed in Poland a strait rather than a basin. It is possible that originally it was wider, but sediments from the present day are preserved only in the tectonical depressions, the so-called marginal syncline of the Russian Platform (POŻARYSKI, 1957). Therefore, we can draw conclusions more concerning its connections than its geographical extent. The included map showing seaways of Danian and Montian times in Middle Europe (Text-plate I) therefore more demonstrates the connections of the sea than its extent.

Investigations of the Danian and Lower Paleocene deposits show that their facial development within the north European basin is strongly differentiated. There are three factors responsible for the facial pattern of the Danian and Montian in this basin: climatic conditions on the one hand, eustatic movements of the sea level and tectonic movements, on the other.

During the Danian the sea was shallower than during the Maastrichtian. Therefore, as a rule, the Danian sediments were formed in the zone influenced by wave action and this accounts for the predominantly calcareous-detritic character of the rock series here. The oceanographic conditions must have been subjected to other more important changes than those of sea depth, which resulted in the occurrence of sedimentary hiatuses and the formation of hard ground on or a little above the boundary of the Maastrichtian and the Danian, as can be seen throughout the whole investigated areas of this enormous basin covering the Crimea, Poland, Denmark, Belgium and the Netherlands. Meanwhile the formation of hard ground goes back somewhat earlier, before the close of the Maastrichtian, as indicated by investigations carried out in central Poland at Góra Puławska and Żyrzyn and is also the case in the Maastrichtian of Møns Klint in Denmark.

The predominant facies within these areas where no tectonic movements occurred at the boundary of the Cretaceous and the Tertiary — i.e. in the uppermost Maastrichtian, Danian and Lower Paleocene — was calcareous zoogenic, pelitic and calcareous-detritic. This applies to sediments of the Danian and the Montian in the Crimea, the Danian of Denmark and Sweden, the Danian and the Montian of Belgium and the Danian of the Netherlands. The arenaceous, glauconitic-quartz and argillaceous facies is, on the other hand, associated mainly with the area of central Poland where intense Laramide movements began in the middle of the Maastrichtian

and continued up to the Paleocene. The more recently elevated area (Middle European Land) supplied great quantities of detritic material to the Danian and Paleocene sea. At the same time, in north-eastern Poland, where the Laramide orogeny probably in this period was not manifested and where the Upper Cretaceous sea had not retreated during the Danian, considerable terrigenous material was brought in from the Scandinavian shield (North Baltic Land) lying to the north. This inflow lasted unbroken throughout the Upper Cretaceous, at least from the beginning of the Upper Cretaceous transgression.

In the Jutland peninsula and on Zealand as well as in the neighbouring Scania, the Laramide movements were equally strong, but seem to be dominating during the Lower Paleocene. The sandiness of that stage (Selandian) is probably there due to diastrophism during the youngest phase of the Laramide orogeny.

To sum up, the Danian has throughout northern Europe a transgressive character usually starting with a basal conglomerate. In Poland, however, no basal conglomerate sensu stricto has so far been found. Yet the presence of coarser grains and a more abundant inflow of detritic material has been observed at the base of this series in the Danian deposits reached by borings. Moreover, at Bochotnica and Nasiłów, also at the Magnuszew and Pamiętowo borings we are dealing with an extremely thin, remnant layer of the Danian. Its composition corresponds to the basal conglomerate, since it contains abundant Maastrichtian rock material and redeposited fossil remains. The rock material from that conglomerate has partly contributed to the building up of the basal conglomerate of the next Paleocene series.

In Denmark (Zealand) the basal conglomerate is represented by a thin „Fish Clay" layer which contains numerous chalk pebbles and generally a reworked Maastrichtian microfauna. The basal conglomerate of the Danian is absent in some localities in eastern Zealand, as well as in Sweden (Scania, Limhamn).

In Belgium (Bassin de Mons) the basal conglomerate of the Danian, represented there by the Tuffeau de Ciply, is well developed as Poudingue de la Malogne. Here it consists of hard ground with pockets. Within the glauconite sediment that fills in the canals phosphate concretions and numerous remains of pectinids *(Pecten pulchellus)*, oysters *(Ostrea lunata)* and belemnite rostra are embedded.

In the Belgian-Dutch province of Limburg (Vroenhoven, Curfs-Geulhem) the basal conglomerate layer has an equivalent in a bed resting directly on the hard ground of the Upper Maastrichtian at Vroenhoven, and particularly at Geulhem (Curfs quarry). This consists of reworked Maastrichtian material with belemnite remains, pectenids and other Upper Maastrichtian fossils, side by side with the first specimens of *Globigerina daubjergensis*.

In south-western Crimea the conditions are analogous, except that *Globigerina daubjergensis* is not recorded there earlier than in the Upper Danian (Morozova, 1959). The Danian series starts there with a thin glauconite layer with phosphatic nodules resting on a hard ground layer of the Maastrichtian, containing relatively numerous reworked rostra of belemnites.

Thus it can be seen that the fundamental changes in the hydrodynamic régime at the boundary of the Maastrichtian and the Danian as well as the resulting sedimentary hiatus and the formation of the hard ground bottom, was a common and large-scale phenomenon. Such distant countries as the Crimea, Poland, Belgium, the Netherlands and Denmark, all came within the reach of its activities. This phenomenon was connected with the Laramide orogeny which was responsible for the emergence of certain land areas (see Text-plate I) and for the shallowing sea that persisted along the western peripheries of the East-European Platform within the so-called Polish-Danish syncline (Pożaryski, 1957). This unbalancing of the equilibrium in the hydrodynamic régime of the sea basin under consideration was not associated

with a complete regression of the sea but merely with a considerable shallowing process, hence with a more copious supply of terrigenous material. In certain areas, e.g. on the north Bulgarian platform, the sea receded completely towards the close of the Maastrichtian.

During the Lower Paleocene, the deposition of Montian sediments in Europe started with coarse-grained material. In some places it was represented by a basal conglomerate, elsewhere merely by the presence of coarser material. The presence of a basal conglomerate is associated with a sedimentary hiatus and distinct facial changes. This happens in Denmark (Copenhagen, Hvalløse, Lellinge) and Sweden (Klagshamn) where the Lower Paleocene (Selandian) sedimentation is expressed by deposits completely different from the underlying Danian rocks. No basal conglomerate has formed, however, in regions where a longer sedimentary hiatus did not occur at the boundary of the Danian and the Montian and where deposits of the Paleocene do not facially differ from those of the Danian. Such was the case in Poland and the Crimea, as well as in the Belgian-Dutch Limburg and at Mons. In all these areas the facies of the Montian resembles very much that of the Danian. It is only at the boundary of these series that we may come across the presence of coarser grains in Poland (POŻARYSKA, 1952, 1964) or an admixture of quartz grains in calcareous deposits in Mons Basin (MARLIÈRE, 1957), even phosphatic concretions (very minute) which have also been encountered in south-western Crimea within a calcareous Danian-Montian series (MOSKVIN, 1959).

To sum up the results of our investigations on the Danian and Montian sediments in Poland, the following conclusions can be reasonably applied to Poland and also to the whole of central Europe, where the sediments under consideration occur in the epicontinental facies.

1. The Danian and Montian deposits in Europe are preserved mainly along the western and southern margins of the East-European Platform which subsides in the direction of the geosynclines that surround the Platform.
2. The Danian and the Montian are two separate stratigraphic units. Their independence has been established in the Mons region where the series Tuffeau de Ciply underlying the Montian deposits (Calcaires de Mons) has been recently referred to the Danian.
3. A strongly reduced series of Danian deposits, locally preserved as remnants only, has been found in Poland below the Montian deposits.
4. The Danian is a stratigraphic unit whose fauna differs very substantially from the Maastrichtian, but only slightly from the Montian. This has been proved in the present paper on foraminiferal evidence. Thus the Danian could be numbered as a lowermost Paleocene.
5. While there are no index fossils in Poland restricted only to the Danian, deposits of the Montian are adequately characterized by a score or more of foraminiferal species.
6. The Danian sedimentation begins either with a basal conglomerate represented by glauconitic-phosphatic nodules, or with an arenaceous-glauconitic sediment occurring on a corroded hard ground surface of the Upper Maastrichtian. This indicates that the time lapse between the Maastrichtian and the Danian may have been fairly long thus accounting for the change in the character of the fauna.
7. The sedimentation of the Montian seldom begins with a basal conglomerate. Yet nevertheless the presence of coarser granulation is observable at the base of these Montian deposits (Poland, Belgium — Mons, Crimea). This might suggest a slight disturbance in the equilibrium (rupture d'équilibre; L. CAYEUX, 1940), whereas the presence of basal conglomerate (Klagshamn, Copenhagen, Lellinge and Hvalløse), indicates a somewhat longer time interval.

8. The facial differences between the Maastrichtian and the Danian are generally strongly marked, but the change of facies, always observable at the boundary of the Maastrichtian and the Danian, began here at some earlier time. In the area of Mons the whole Upper Maastrichtian is developed in a facies similar to the Danian, while in Denmark, bryozoan bioherms, well developed in the Danian, make their first appearance already in the uppermost chalk horizons. In Poland, the uppermost local horizon of the Maastrichtian — the Żyrzyn beds — is developed in a glauconite-marly facies, almost analogous to that of the Danian. In the Crimea, Maastrichtian marls became sandy in the highest horizons, while the lowermost beds of the Danian are represented by analogous sandy marls.
9. In Poland, the Crimea and Belgium (Mons) the facies of the Danian deposits are graded gradually into the Montian sediments.
10. The Danian sea was probably deeper in the Baltic and Black Sea basins than in the Polish basin. This is suggested by the lack in Poland of the calcareous series which represent the Danian sediments in Scandinavia and Belgium, as well as in the Crimea and Georgia. Most likely the Danian sea in Poland was shallow which could be explained by the strong upheaval of the area occupied by central Poland during the Laramide orogeny.
11. Concentrations of belemnites are observable in many countries at the boundary of the Cretaceous and the Tertiary:

    a) in the uppermost Maastrichtian, e.g. in Poland at the base of the Żyrzyn beds,

    b) in Danian basal conglomerate, e.g. at Mons (Poudingue de la Malogne), Limburg — Geulhem, the Crimea — Salaczik and the Indol region, in Poland at Bochotnica and Nasiłów phosphatic bed, in the lower part of the local »z« horizon,

    c) at the base of the Montian in Poland (Bochotnica and Nasiłów), in the phosphatic bed, upper part of the local »z« horizon.

    Example a) excepted, the belemnites are everywhere reworked and mixed with sediments deposited on the surface of a hard ground layer.
12. In the light of the present investigations on the foraminiferal microfauna, it seems more reasonable to place the Danian stage in the lowermost Tertiary than in the uppermost Cretaceous. This astonishing phenomenon of a sharply outlined faunistic boundary, unrelated to any sudden change in a facies, must be caused by more important factors, probably the same which contributed to the extinction of the inoceramids, true belemnites (Belemnitellidae), ammonites, dinosaurs, etc. which during that era disappeared all over the world (NAJDIN, 1960, 1965; POSLAVSKAJA & MOSKVIN, 1960; ROSENKRANTZ, 1960; JELETZKY, 1963, BRAMLETTE & MARTINI, 1964). The conclusion can, however, be drawn that, as regards foraminifers, the main change in the fauna between the Cretaceous and the Tertiary, took place at the end of the Maastrichtian (BYKOVA, 1960; MOROZOVA, 1960; SCHUTZKAJA, 1962; LUTERBACHER & SILVA, 1964). In other continents the Danian is ranged within the Paleocene as its lower part (LOEBLICH & TAPPAN, 1957*b*; LOEBLICH, TAPPAN, BECKMANN et al., 1957; TROELSEN, 1957; HORNIBROOK, 1962). This would be an additional evidence in favour of attribution of the Danian to the Tertiary with the reservation that observations of one animal group alone cannot definitely solve this problem. As is well-known from the considerations of previous authors, among others RAVN and, more recently, BROTZEN, this does, in their opinion, not apply to other animal groups. An analysis of the total faunistic and floristic changes during that period will definitely solve this problem.

SYSTEMATIC PART

DESCRIPTIONS

Family LITUOLIDAE REUSS, 1861

Genus **FRANKEINA** CUSHMAN & ALEXANDER, 1929

Frankeina beisseli MARIE, 1941

(Plate II, figs. 1*a-b*)

1941. *Frankeina Beisseli* MARIE; P. MARIE, Les Foraminifères..., p. 23, pl. 2, fig. 12*a-c* (earlier synonymy included).

Material. — Single specimen, well preserved.
Dimensions (in mm.):

Length of test	1·18
Maximum width of test	0·85

Description. — Test large, massive, elongated, angular, ridge-shaped, triangular in transverse section, sides plane or slightly concave, marginal ridges truncate. Chambers not visible. Sutures slightly depressed. Aperture, an elongated slit at the top of the last formed chamber. Wall coarsely arenaceous, with very large, irregular grains protruding throughout all the test, especially along the marginal ridges.

Remarks. — Our specimen does not differ from the holotype described by MARIE from Paris Basin. Similar to *Clavulina angularis* D'ORB. (microspheric form), figured by PLUMMER (1926, p. 70, pl. 2, fig. 4).

Distribution. — Single specimen has been found in Montian at Boryszew boring. Probably reworked. Rare in Maastrichtian in Limburg region, very rare in Paris Basin.

Family TEXTULARIIDAE D'ORBIGNY, 1846

Genus **SPIROPLECTAMMINA** CUSHMAN, 1927

Spiroplectammina baudouiniana (D'ORBIGNY, 1840)

(Plate II, figs. 5*a-b*)

1840. *Textularia Baudouiniana* D'ORBIGNY; A. D'ORBIGNY, Mémoires sur les Foraminifères..., p. 46, pl. 4, fig. 29, 30.

1928. *Textularia baudouiniana* D'ORBIGNY; A. FRANKE, Die Foraminiferen der Oberen Kreide Nord- u. Mitteldeutschlands, p. 135, pl. 12, fig. 12*a-b*.

1937. *Textularia baudouiniana* D'ORBIGNY; N. A. KALININ, Foraminifery melovych otloženij..., p. 13, pl. 1, fig. 1, 2.
1941. *Textularia Baudouiniana* D'ORBIGNY; P. MARIE, Les Foraminifères..., p. 63, pl. 2, fig. 21.
1946. *Spiroplectammina baudouiniana* (D'ORBIGNY); J. A. CUSHMAN, Upper Cretaceous Foraminifera..., p. 25, pl. 5, fig. 12.
1959. *Textularia baudouiniana* D'ORBIGNY; M. M. MOSKVIN, Atlas..., p. 91, pl. 2, fig. 4.
1961. *Spiroplectammina baudouiniana* (D'ORBIGNY); V. S. AKIMEC, Stratigrafija i foraminifery..., p. 74, pl. 1, fig. 8, 9.

Material. — About 100 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·80
Maximum width of test	0·64
Thickness of test	0·46

Description. — Test large, broadly tapering, rhomboidal in the section, greatest breadth near apertural end, thick, with greatest thickness near median line. Periphery subacute. Chambers distinct, numerous, coiled in early portion. In the remainder of test chambers biserial, low and broad. Sutures very distinct, slightly curved, usually not depressed, flush with surface of test. Aperture, low opening at base of the last formed chamber. Wall coarsely arenaceous.

Remarks. — Our specimens do not differ from specimens occurring in the European Upper Cretaceous, but differ from American ones, having much coarser walls.

Distribution. — Known from Upper Cretaceous. In Poland some specimens in phosphoritic layer of Danian age, just on Upper Maastrichtian, where they are probably derived. Similar species occur in whole Danian and Selandian in Denmark as well as in Calcaire Pisolithique in Paris Basin.

Spiroplectammina suturalis (KALININ, 1937)

(Plate III, figs. 9, 10)

1937. *Bolivinopsis suturalis* KALININ; N. A. KALININ, Foraminifery melovych otloženij..., p. 15, pl. 1, fig. 5.
1961. *Spiroplectammina suturalis* (KALININ); V. S. AKIMEC, Stratigrafija i foraminifery..., p. 75, pl. 1, fig. 11.

Material. — Some specimens, elongated part of test damaged.
Dimensions of 2 specimens (in mm.):

	1	*2*
Length of test	0·95	0·70
Maximum width of test	0·57	0·43
Thickness of test	0·22	0·25

Description. — Peripheral margin lobulate. Test elongated, inflated, compressed, planispiral portion not so broad as remainder of test, sides nearly parallel, broadening slightly towards apertural end. Chambers numerous, 5-6 in the coiled portion, biserially arranged in elongated part. Chambers low and broad, sometimes depressed. Sutures distinct, straight or slightly curved. In some specimens sutures thick and higher than the surface of chambers. Aperture a low slit at the inner margin of last formed chamber. Wall arenaceous, rather coarse.

Variation. — Considerable in general shape and in sutures which can be more distinct, limbate or less distinct.

Remarks. — Similar to *S. mexiaensis* LALICKER, described from the Midway formation. Our specimens differ from American ones by having a smaller planispiral portion in relation to the biserial one and having the wall not so finely arenaceous. They differ from the holotype by having a short spiral with only 5-6 chambers instead of numerous chambers in a twice coiled spiral as in Russian specimens.

Distribution. — Known from Upper Cretaceous of U.S.S.R., where it is common. Not known from Limburg and Paris Basin. In Poland this species occurs in Upper Maastrichtian at Góra Puławska, Żyrzyn, Sochaczew, and in Danian at Bochotnica. Not common.

Spiroplectammina wilcoxensis CUSHMAN & PONTON, 1932

(Plate III, figs. 1 *a-b*)

1932. *Spiroplectammina wilcoxensis* CUSHMAN & PONTON; J. A. CUSHMAN & G. M. PONTON, An Eocene foraminiferal fauna..., p. 51, pl. 7, fig. 1.
1941. *Spiroplectammina wilcoxensis* TOULMIN; D. L. TOULMIN, Eocene smaller Foraminifera..., p. 571, pl. 78, fig. 1.
1948. *Spiroplectammina wilcoxensis* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 34, fig. 6, 2 on p. 38.
1951. *Spiroplectammina wilcoxensis* CUSHMAN; J. A. CUSHMAN, Paleocene Foraminifera..., p. 6, pl. 1, fig. 21-23.
1960. *Spiroplectammina wilcoxensis* OLSSON; R. K. OLSSON, Foraminifera of latest Cretaceous..., p. 5, pl. 1, fig. 3.

Material. — Several specimens, often damaged at both ends.
Dimensions of an average specimen (in mm.):

Length of test	0·51
Maximum width of test	0·24
Thickness of test	0·14

Description. — Test long, broad, compressed, oval, elongated in the section, rounded periphery, in the early portion chambers numerous, coiled, later biserial, gradually increasing in height as added. Sutures distinct, slightly depressed, gently curved. Facial surface convex. Aperture forms an elongated slit at the base of last formed chamber. Wall smoothly arenaceous.

Variation. — Rather great in the character of sutures which can be more depressed or less and sometimes not seen in early portion at all. Our specimens do not differ from the holotype described from North America.

Remarks. — *Spiroplectammina wilcoxensis* from Poland does not differ in proportion from the holotype. It resembles in size rather specimens from Swedish Paleocene, but is usually larger (BROTZEN, 1948). Very abundant in all Swedish Paleocene localities as well as from the Danish Lower Paleocene. The same species was described from Midway and Eocene in Alabama. It was described also from the Wilcox group of Eocene age from Alabama. Similar at first glance to *Spiroplectammina laevis* (ROEMER) from the Cretaceous, the latter being not so long, with angular margins.

Distribution. — Common in Danian and Montian in all Polish borings as well as in Swedish and Danish Selandian. Known from the Midway and Wilcox formations in America. Present in the Danian of Limburg and in Upper Danian of Denmark (Hvalløse).

Genus **TEXTULARIA** DEFRANCE, 1824

Textularia plummerae arkansasana CUSHMAN, 1951

(Plate I, figs. 6*a-b*)

1926. *Textularia eocaena* (GÜMBEL); H. J. PLUMMER, Foraminifera of the Midway Formation..., p. 67, pl. 3, fig. 2.
1935. *Textularia plummerae* LALICKER; C. G. LALICKER, New Tertiary Textulariidae, p. 50, pl. 6, fig. 10*a-c*.
1941. *Textularia plummerae* LALICKER; E. F. DAVIS, Textularia from the Texas Tertiary, p. 15, pl. 25, fig. 8, 9.
1941. *Textularia plummerae* (LALICKER); D. L. TOULMIN, Eocene smaller Foraminifera..., p. 572, pl. 78, fig. 3.
1951. *Textularia plummerae* LALICKER var. *arkansasana* CUSHMAN; J. A. CUSHMAN, Paleocene Foraminifera..., p. 7, pl. 2, fig. 4, 5.
?1957. *Textularia agglutissima* HOFKER; J. HOFKER, Foraminifera from the Cretaceous..., XXXI, p. 149, text-fig. 1, 2.
1958. *Textularia plummerae* (LALICKER); J. HOFKER, *Ibid.*, XXXII, p. 24, text-fig. 6.

Material. — Few specimens, damaged at both ends.
Dimensions of an average specimen (in mm.):

Length of test	1·26
Maximum width of test	0·59
Thickness of test	0·56

Description. — Test elongated, about 3 times as long as broad, slightly tapering, compressed, periphery rounded, sides parallel in the last portion. Chambers gradually increasing in size as added. Sutures distinct, slightly depressed, straight. Facial surface convex. Aperture great, round, sometimes a low arched slit at the base of last formed chamber. Wall coarsely arenaceous, composed of fine and coarse sand grains which are sometimes prominent, so the wall surface is rather rugged.

Variation. — Mainly in the character of surface which can be more or less rough.

Remarks. — Polish specimens differ from the holotype. Their test is broader and chambers not so high. Much coarser arenaceous wall than the typical species *Textularia plummerae* LALICKER. *Textularia porrecta* BRADY, described from the recent Oceans by BRADY, is very close to *T. plummerae* LALICKER.

Distribution. — Rare in Danian as well as in Montian. Present in Boryszew and Góra Puławska, known from Montian Calcaire Pisolithique, Upper Danian and Montian in the Netherlands and Denmark. Described from the Midway of America where it is rather common. In Texas very common not only in the Midway but also in younger Tertiary formations. Present in the Tuffeau de Ciply (Danian) and Calcaire de Mons (Montian).

Family VERNEUILINIDAE CUSHMAN, 1911

Genus **VERNEUILINA** D'ORBIGNY, 1840

Verneuilina monmouthensis OLSSON, 1960

(Plate IV, fig. 4)

1960. *Verneuilina monmouthensis* OLSSON; R. K. OLSSON, Foraminifera..., p. 8, pl. 1, fig. 7, 8.

Material. — 6 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·55
Maximum width of test	0·43
Thickness of test	0·30

Description. — Test very short, as long as broad, rapidly tapering, in section triangular, subacute angles, facial surface convex. Chambers increasing in size as added, triserial, inflated, overlapping, sutures flush with test surface, sometimes indistinct, the last slightly depressed. Aperture, a narrow slit at the base of last chamber. Wall arenaceous not very smooth.

Variation. — Not known, due to scarcity of material.

Remarks. — *Gaudryina pyramidata* CUSHMAN occurs in the Maastrichtian, but a short varietas is very similar to *Verneuilina monmouthensis* OLSSON from the Danian and Paleocene. According to Mr P. N. WEBB's personal communication, forms such as *Verneuilina monmouthensis* OLSSON are possibly the early ontogenetic forms of juvenile species of some *Gaudryina* species.

Distribution. — Not common in Poland, known from Danian and Montian of Żyrzyn, Sochaczew and Boryszew. Specimens from Maastrichtian of Sochaczew may not belong to this species. Known from N Egypt and Hornerstown formations in New Jersey, where it commonly occurs (Paleocene). Common in North America in Eocene.

Genus **GAUDRYINA** D'ORBIGNY, 1839

Gaudryina (Textularia) faujasi (REUSS, 1861)

(Plate IV, figs. 2, 3*a-b*)

?1861. *Textilaria Faujasi* REUSS; A. E. REUSS, Paläontologische Beiträge..., p. 320, pl. 3, fig. 9*a-b*.

1958. *Gaudryina (Textularia) faujasi* REUSS; J. HOFKER, Foraminifera from the Cretaceous..., XXXII, p. 22. text-fig. 1-4.

1959. *Textularia (Gaudryina) faujasi* REUSS; J. HOFKER, *Ibid.*, XXXIX, p. 25.

Material. — A dozen specimens or so.

Dimensions of 2 specimens (in mm.):

	1	*2*
Length of test	1·45	1·20
Maximum width of test	0·80	0·72
Thickness of test	0·75	—

Description. — Test large, massive, very thick, elongated, compressed, tapering, outline slightly lobulate, initial end bluntly acute, apertural end broadly rounded, some specimens have the early portion of test triserial, the remainder biserial, some are biserial throughout the test. Chambers low, trapezoidal, the last tending to become crescent, up to 6 in one row. Sutures distinct, depressed, parallel on the broad marginal side in the biserial part of test. Apertural surface broadly rounded. Aperture, a slit at the base of last formed chamber. Wall coarsely arenaceous.

Variation. — Considerable; applies mainly to the general shape of test which can be more flattened or less, rectangular or triangular in transverse section, broadly rounded or acute.

Remarks. — Our specimens differ from the holotype, described by REUSS, by not tapering so rapidly and by not having such sharp margins. They are rather close to specimens figured by HOFKER (1958) from the Danian of the Netherlands (Curfs quarry). HOFKER (1958) put forward the supposition of three generations in *Gaudryina faujasi*: A_1 — generation with acute margin, A_2 — generation with rounded margin, and B — generation with triangular initial part. The two first generations, i.e. A_1 and A_2, are called by HOFKER the *Textularia* generations, the third — B — *Gaudryina* generation. In the so-called *Me* at Limburg (HOFKER's Paleocene, MEIJER's Danian) the representatives of all three generations were found together. Higher up

in the section the A_2 *(Textularia)* generation becomes the dominating one and finally is the only generation to be found. If this supposition of HOFKER is correct, then our figured specimens belong to the A_2 generation with broad, rounded margins.

Distribution. — Rare in uppermost Maastrichtian and Danian at Sochaczew. Rare in Montian at Boryszew. This species is known from Maastrichtian, Danian and Montian of the Netherlands, from Danian of Denmark, from Tuffeau de Ciply and from North America.

Gaudryina cf. **bulloides** OLSSON, 1960

(Plate IV, figs. 1*a-b*, 6*a-b*)

1960. *Gaudryina bulloides* OLSSON; R. K. OLSSON, Foraminifera..., p. 6, pl. 1, fig. 12-13.

Material. — A dozen or so specimens, well preserved.
Dimensions of 2 specimens (in mm.):

	1	*2*
Length of test	0·84	0·60
Maximum width of test	0·50	0·35

Description. — Test elongated, slightly tapering, bluntly angular at initial end, broadly rounded at apertural end, chambers arranged triserially in the earlier portion, biserial portion rather short. Chambers inflated, gradually increasing in size as added, only two in number in biserial portion. Sutures distinct, depressed. Aperture, a loop-shape at the base of last formed chamber. Wall smoothly arenaceous.

Variation. — Considerable; it applies to the shape of chambers which are more inflated or less, and to general arrangement of chambers which, being in the early portion of test not always triserial, is more irregular or less so.

Remarks. — Some of our specimens do not differ from the holotype described by OLSSON (1960).

Distribution. — In phosphoritic layer at Bochotnica (Danian) and in Boryszew (probably derived). This species occurs in Maastrichtian of North America. A similar species — *Gaudryina askfordi* BOWEN, 1954, is described from London Clay, but it is different from our specimens by having a very short triserial part of test, comprising only about one-fifth of the length of test, while here the triserial portion dominates.

Gaudryina cf. **rugosa rossica** BALAKHMATOVA, 1955

(Plate I, figs. 1, 7)

1955. *Gaudryina rugosa rossica* BALAKHMATOVA; V. T. BALAKHMATOVA *et al.*, Charakternye foraminifery..., p. 27, pl. 2, fig. 6.

1959. *Gaudryina rugosa rossica* BALAKHMATOVA; D. M. RAUZER-ČERNOUSOVA & A. V. FURSENKO, Osnovy paleontologii, p. 223, text-fig. 240.

Material. — Two specimens, well preserved.
Dimensions of two specimens (in mm.):

	1	*2*
Length of test	1·50	1·90
Maximum width of test	0·75	0·95
Thickness of test	0·70	0·80

Description. — Test moderately tapering, triangular in early portion, rectangular in remainder of test, where chambers are arranged biserially. Initial end bluntly acute, apertural end broadly rounded. Chambers low, angular, numerous, up to 6 in one row. Sutures straight, slightly depressed, fairly visible, parallel on the periphery. Facial surface low, slightly convex. Aperture, an elongated, broad slit at the base of last formed chamber. Wall very coarsely arenaceous, with big, angulate grains, protruding irregularly throughout the test.

Variation. — Not known, due to scarcity of material.

Remarks. — Our specimens are most similar to *Gaudryina rugosa rossica* BALAKHMATOVA, 1955, from Maastrichtian of Siberia (U. S. S. R.).

Distribution. — Few specimens in Danian and in Montian at Pamiętowo. Probably reworked.

Family VALVULINIDAE CUSHMAN, 1927

Genus CLAVULINA D'ORBIGNY, 1826

Clavulina parisiensis D'ORBIGNY, 1826

(Plate IV, fig. 9)

1826. *Clavulina Parisiensis* D'ORB.; A. D'ORBIGNY, Tableau méthodique..., Modèles, no. 66 (*fide* ELLIS & MESSINA Catal. of Foraminifera).
?1884. *Clavulina parisiensis* D'ORB.; H. B. BRADY, Report on the Foraminifera..., p. 395, pl. 48, fig. 14-18.
1900. *Clavulina Parisiensis* D'ORB.; J. G. EGGER, Foraminiferen und Ostrakoden aus den Kreidemergeln der Oberbayerischen Alpen, p. 44, pl. 16, fig. 22, 23, 50, 51.
?1910. *Clavulina parisiensis* D'ORB.; J. A. CUSHMAN, Foraminifera of North Pacific..., p. 75, fig. 123, 124.
1927. *Clavulina parisiensis* D'ORB.; A. FRANKE, Die Foraminiferen und Ostracoden..., p. 10, pl. 1, fig. 6.
non 1932. *Clavulina parisiensis* D'ORB.; J. R. SANDIDGE, Foraminifera..., p. 269, pl. 41, fig. 12.
1960. *Clavulina parisiensis* D'ORB.; D. CURRY, Eocene limestones..., p. 293.

Material. — 4 specimens, well preserved.

Dimensions of an average specimen (in mm.):

Length of test	1·13
Maximum width of test	0·30

Description. — Test elongated, earlier portion short, chambers arranged triserially, the remainder of test arranged uniserially. Chambers distinct, inflated, moderately increasing in size as added, sutures distinctly depressed. Initial end acute, apertural end broadly rounded. Aperture round on the top of last formed chamber. Wall smoothly arenaceous.

Variation. — Not known, due to scarcity of material.

Remarks. — More common in Montian of Poland is a similar species *Bermudezina* cf. *bentonensiformis* HOFKER, 1958, with a longer, triserial part of test and shorter biserial remainder of test. Similar to *Pseudoclavulina anglica* CUSHMAN (1936), from which our specimens differ in having broader triserial part than the remainder of test, and more depressed sutures.

Distribution. — Very rare in Montian at Góra Puławska and Żyrzyn. Known from the Paleocene of Denmark, Sweden, Germany, France and the Netherlands. More common in rather younger strata than in those of Lower Paleocene age.

Genus **MARSSONELLA** CUSHMAN, 1933

Marssonella oxycona (REUSS, 1860)

(Plate II, figs. 2, 3)

1860. *Gaudryina oxycona* REUSS; A. E. REUSS, Die Foraminiferen der Westphälischen Kreideformation, p. 229 pl. 12, fig. 3.
1878. *Gaudryina oxycona* REUSS; T. MARSSON, Die Foraminiferen..., p. 158.
1900. *Gaudryina oxycona* REUSS; J. G. EGGER, Foraminiferen und Ostrakoden aus den Kreidemergeln der Oberbayerischen Alpen, p. 38, pl. 4, fig. 1-3.
1933. *Marssonella oxycona* (REUSS); J. A. CUSHMAN, New American Cretaceous..., p. 36, pl. 4, fig. 13.
1937. *Marssonella oxycona* (REUSS); N. A. KALININ, Foraminifery melovych otloženij..., p. 19, pl, 1, fig. 12-13.
1937. *Marssonella oxycona* (REUSS); J. A. CUSHMAN, A Monograph..., pl. 5, fig. 27; pl. 6, fig. 3-5, 8-12 (earlier synonymy included).
1941. *Marssonella oxycona* (REUSS); D. L. TOULMIN, Eocene smaller Foraminifera..., p. 573, pl. 78, fig. 12-13.
1946. *Marssonella oxycona* (REUSS); J. A. CUSHMAN, Upper Cretaceous Foraminifera..., p. 43, pl. 12, fig. 3-5.
1951. *Marssonella oxycona* (REUSS); J. A. CUSHMAN, Paleocene Foraminifera..., p. 9, pl. 2, fig. 21.
1954. *Marssonella oxycona* (REUSS); L. DON FRIZZELL, Handbook..., p. 75, pl. 6, fig. 17.
1956. *Marssonella oxycona* (REUSS); J. HOFKER, Die *Pseudotextularia*-Zone..., p. 64, pl. 5, fig. 6.
1957. *Marssonella oxycona* (REUSS); J. HOFKER, Foraminiferen der Oberkreide..., p. 85, fig. 86-90.
1962. *Marssonella oxycona* (REUSS); E. M. SCHMID, Die Foraminiferenfauna..., p. 322, pl. 1, fig. 5.

Material. — About 30 specimens, some of them damaged at the apertural end. Dimensions of two specimens (in mm.):

	1	*2*
Height of test	0·36	0·86
Maximum width of test	0·40	0·67

Description. — Test conical, sometimes longer, sometimes shorter, gradually tapering rounded in transverse section; chambers and sutures not always distinct. The last chambers biserial. Between two rows of chambers, a zigzag-shaped suture flush with surface. The last chamber overlapping the former one and sometimes overhanging it. Their periphery rounded. Apertural face flattened, or concave. Aperture forms a narrow slit, extending from base into face of last chamber. Wall coarsely or finely arenaceous. Chambers alternate throughout.

Variation. — Considerable; in the general shape more conical or less, in the structure of wall which can be very coarse with some big quartz grains, or smoothly arenaceous.

Distribution. — Very common in the Upper Maastrichtian as well as in the Danian. Not restricted only to the Cretaceous. From the U. S. Gulf Coastal Region quoted in the basal part of the Midway group as reworked, rare, poorly preserved specimens. Present in Danian (?) of Austria.

Genus **DOROTHIA** PLUMMER, 1931

Dorothia monmouthensis OLSSON, 1960

(Plate IV, figs. 7*a-c*)

1960. *Dorothia monmouthensis* OLSSON; R. K. OLSSON, Foraminifera..., p. 7, pl. 1, fig. 9-10.

Material. — Few specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·74
Maximum width of test	0·54
Thickness of test	0·35

Description. — Test cylindrical, slightly tapering, broadly rounded at base, oval, nearly round in the section. Chambers biserial, inflated, overlapping. Sutures indistinct in initial part, slightly depressed in biserial portion. Facial surface slightly convex. Aperture forms an elongated slit at the base of last formed chamber. Test smoothly arenaceous.

Variation. — Not known due to scarcity of material.

Remarks. — Our specimens differ only insignificantly from American ones, not having parallel sides of biserial portion. A very similar species was described in New Zealand as *Dorothia biformis* FINLAY from Maastrichtian (Trans. roy. Soc. NZ., 69, 3, 313, Pl. 25, fig. 26-28, 1939), where it is used as index species (P. N. WEBB, personal communication). *D. biformis* FINLAY also occurs in Campanian sediments in Western Australia (BELFORD, 1960).

Distribution. — Very rare in Poland. Known in few specimens from Boryszew only. Probably derived from Maastrichtian. Described from Navarro (Maastrichtian) formation in New Jersey.

Genus **ATAXOPHRAGMOIDES** BROTZEN, 1948

Ataxophragmoides frankei BROTZEN, 1948

(Plate I, figs. 5*a-b*)

1948. *Ataxophragmoides frankei* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 36, pl. 5, fig. 6.
1956. *Orbignyna frankei* (BROTZEN); J. HOFKER, Foraminifera from the Cretaceous..., XIV, p. 17, fig. 4-D (non fig. 4A-C).

Material. — 48 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·80
Shortest diameter of test	0·60

Description. — Test subglobular or globular, rather big. First whorls indistinct, the last entirely overlapping first whorls, forming the majority of the test as in *Arenobulimina*. Five chambers in last whorl. Sutures distinct, depressed. Apertural face slightly convex. Aperture big, round or crescent. Wall coarsely arenaceous, with isolated large grains and a lot of cement.

Variation. — In size rather than in shape.

Remarks. — Rather common in coarse detritic sandy layers. Our specimens do not differ from the holotype.

Distribution. — Known from the Cretaceous of Limburg and the Swedish and Danish Danian and Selandian. Present in Danian and Montian of Bochotnica, Góra Puławska and in the Maastrichtian of Pamiętowo and Sochaczew. Probably reworked. HOFKER (1956) described trimorphic development of this species.

Genus **ARENOBULIMINA** CUSHMAN, 1927

Arenobulimina cuskleyae JENNINGS, 1936

(Plate IV, fig. 8)

1936. *Arenobulimina cuskleyae* JENNINGS; P. H. JENNINGS, A microfauna..., p. 13, pl. 1, fig. 8.
1948. *Arenobulimina cuskleyae* JENNINGS; F. BROTZEN, The Swedish Paleocene..., p. 34, pl. 6, fig. 2.
1957. *Arenobulimina cuskleyae* JENNINGS; F. BROTZEN & K. POŻARYSKA, The Paleocene in central Poland, p. 273.
1960. *Arenobulimina cuskleyae* JENNINGS; R. K. OLSSON, Foraminifera..., p. 7, pl. 1, fig. 11.

Material. — A dozen specimens or so.
Dimensions of an average specimen (in mm.):

Length of test	0·52
Thickness of test	0·23

Description. — Test subfusiform, elongated, with ends broadly rounded, composed of 3-4 whorls gradually increasing in size. Spiral sutures depressed obliquely, septal sutures not depressed, slightly limbate. Two last whorls form the largest part of test. 4 chambers in last whorl. Aperture round or comma-shaped in slightly depressed facial surface. Wall smoothly arenaceous.

Variation. — Not known due to scarcity of material.

Remarks. — Our specimens do not differ from Swedish ones. In comparison with the holotype described in U. S. A. from Eocene, Polish specimens have spiral sutures not so depressed. The same applies in comparison with specimens described from New Jersey by OLSSON (1960).

Distribution. — Common in Montian of Sochaczew, Boryszew and Pamiętowo, as well as in Swedish and Danish Paleocene and North America. Not known in Montian (Calcaire Pisolithique) of Paris Basin (P. MARIE, oral information).

Arenobulimina mohreni BROTZEN, 1948

(Plate II, figs. 4*a-b*)

1948. *Arenobulimina mohreni* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 35, pl. 6, fig. 1.
1957. *Arenobulimina mohreni* BROTZEN; F. BROTZEN & K. POŻARYSKA, The Paleocene in central Poland, p. 273.
1960. *Pernerina redbankensis* OLSSON; R. K. OLSSON, Foraminifera..., p. 8, pl. 1, fig. 22-23.

Material. — About 20 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Height of test	1·40
Thickness of test	1·20

Description. — Test subglobular, sometimes round, spiral arrangement of chambers. First chambers not visible, being overlapped by last whorl, which is sometimes a little elongated. 5 chambers in last whorl. Ratio width to height as 3 : 1. Sutures distinct, not depressed, except for the last. Apertural face slightly concave, with a big, distinct, comma-shaped aperture. Test smoothly arenaceous; small equal grains consisting of quartz.

Variation. — Specimens found in Upper Maastrichtian, Danian and Montian differ only in size. Young specimens resemble *Arenobulimina sphaerica* MARIE, described from Upper Cretaceous of Paris Basin (1941).

Remarks. — Specimens found in Poland very similar to Swedish ones. The same moderately large grains of sand, same character of walls and spire. Specimens described by OLSSON (1960) as *Pernerina redbankensis* more rounded, but seem to belong to *Arenobulimina mohreni*. The same smooth, finely arenaceous character of wall; sutures not depressed; same shape of aperture.

Distribution. — Very common in the Maastrichtian of Pamiętowo, in the Danian of Bochotnica and Sochaczew, and in the Montian of Bochotnica, Sochaczew and Boryszew. Present also in the Netherlands from the Maastrichtian chalk to Lower Paleocene, as well as in Danian and Selandian of Denmark and Sweden. Not known from the Montian of Paris Basin.

Arenobulimina sp.

(Plate III, figs. 8*a-b*)

Material. — A dozen specimens or so.
Dimensions of an average specimen (in mm.):

Length of test	0·34
Maximum width of test	0·33

Description. — Test small, very short, nearly as long as broad, rapidly tapering, in transverse section more rounded or less. Facial surface slightly depressed. Two coils visible, the latter forming four-fifths of test. Sutures distinct, very slightly depressed, nearly flush with surface. Initial end acute, apertural end broadly rounded. Aperture loop-shaped, at the base of last formed chamber. Wall very smoothly arenaceous, with calcareous cement.

Distribution. — Rare in Montian at Boryszew and Sochaczew.

Genus **ORBIGNYNA** HAGENOW, 1842

Orbignyna inflata (REUSS, 1850)

(Plate III, figs. 6*a-c*)

1850. *Spirolina inflata* REUSS; A. E. REUSS, Foraminiferen und Entomostraceen des Kreidemergels von Lemberg, p. 16, pl. 2, fig. 5, 6.
1939. *Orbignyna inflata* (REUSS); V. G. MOROZOVA, K stratigrafii..., p. 70, pl. 1, fig. 10, 11.
1939. *Orbignyna ovata* HAGENOW; M. KELLER, Foraminifera der Oberkreide..., p. 6, pl. 2, fig. 10.
1959. *Orbignyna inflata* (REUSS); M. M. MOSKVIN, Atlas..., p. 94, pl. 2, fig. 5.
1963. *Orbignyna inflata* (REUSS); A. M. VOLOŠINA, Nekotorye vidy..., p. 268, pl. 4, fig. 1, 2.

Material. — Few specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	1·44
Shortest diameter of test	0·86
Thickness of test	0·89

Description. — Test big, coiled, thick, insignificantly asymmetrical, more flattened on one side, raised on the other, with slightly depressed central part. Periphery broadly rounded, 7 chambers gradually increasing in size, as added, slightly inflated, compressed. Sutures distinct, slightly depressed, curved. Facial surface very broad, convex. Aperture, a long slit vertical in the central part of facial surface. Wall finely arenaceous.

Variation. — Not known, due to scarcity of material.

Remarks. — Very close to holotype, the latter having more depressed sutures and not so elongate aperture.

Distribution. — Rare in Danian where it is probably reworked. Some specimens at Boryszew and Sochaczew in Upper Cretaceous. Very typical in Middle Danian in Danemark. Common in Upper Cretaceous beds in many regions of U. S. S. R. Very similar species is present in the Cretaceous of Paris Basin, known as *Orbignyna variabilis* (D'ORBIGNY) (D'ORBIGNY, 1840; MARIE, 1941).

Orbignyna ovata HAGENOW, 1842

(Plate III, figs. 2*a-b* — 5*a-b*)

1842. *Orbignyna ovata* v. HAGENOW; F. v. HAGENOW, Monographie..., p. 573, pl. 9, fig. 26*a-d*).
1861. *Haplophragmium ovatum* HAG. sp.; A. E. REUSS, Die Foraminiferen der Rügenschen Kreideversteinerungen, pl. 5, fig. 8*a-b*, 9.
1878. *Lituola ovata* (v. HAG.); T. MARSSON, Die Foraminiferen..., p. 171, pl. 5, fig. 40*a-m*.
1953. *Orbignyna ovata* HAGENOW; T. BARNARD & F. T. BANNER, Arenaceous Foraminifera..., p. 200, pl. 9, fig. 7A-B).
1956. *Orbignyna ovata* HAGENOW; J. HOFKER, Foraminifera from the Cretaceous..., XIV, p. 16, fig. 2B (not 2A).
1961. *Orbignyna ovata* HAGENOW; V. S. AKIMEC, Stratigrafija i foraminifery..., p. 103, pl. 7, fig. 5, 6.

Material. — A dozen or so specimens, usually damaged.

Dimensions of 4 specimens (in mm.):

	1	*2*	*3*	*4*
Longest diameter of test	0·58	0·78	1·22	1·37
Shortest diameter of test	0·43	0·65	0·95	1·10
Thickness of test	0·27	0·40	0·45	0·54

Description. — Test rather big, planispiral, about as long as broad, sometimes a little elongated, coiled, compressed, more flattened or less. Periphery broadly rounded. Chambers few, 4-7, overlapping, lobe-shaped, rapidly increasing in size as added, last crescent, strongly overlapping the preceding ones. Sutures distinct, curved, sickle-shapped, slightly depressed. Last chamber much bigger, sometimes elongated. Aperture round or triangular, large on the top of facial surface or just below the top. Wall coarsely arenaceous, often rather roughly finished. All the periphery coarsely arenaceous.

Variation. — Marked in general shape, as well as in thickness. Shape of aperture varies from round to oval, sometimes more elongated, sometimes less, to triangular.

Remarks. — *Orbignyna ovata* is most similar to *O. inflata* (REUSS). The latter differing by being thicker and having slightly curved, not sickle shaped sutures. In comparison with the holotype, presented by REUSS from the Rügen's chalk, our specimens are more flattened.

Distribution. — Common in all Maastrichtian of Limburg, Sweden, Germany and England. Known in Maastrichtian as well as in Danian and Montian at Bochotnica, Góra Puławska, Żyrzyn and Boryszew. In Danian and Montian probably derived.

Orbignyna rimosa (MARSSON, 1878)

(Plate I, fig. 3)

1878. *Bulimina rimosa* MARSSON; T. MARSSON, Foraminiferen..., p. 153, pl. 3, fig. 21.
1925. *Bulimina ovata* (HAG.) var. *ruegensis* FRANKE; A. FRANKE, Die Foraminiferen der pommerschen Kreide, p. 82, pl. 7, fig. 5.
1925. *Bulimina rimosa* MARSSON; A. FRANKE, *Ibid.*, p. 23, pl. 2, fig. 13*a-b*.
1937. *Ataxophragmium rimosum* (MARSSON); N. A. KALININ, Foraminifery melovych otloženij..., p. 23, pl. 2, fig. 20-21.
1956. *Orbignyna rimosa* (MARSSON); J. HOFKER, Foraminifera from the Cretaceous..., XIV, p. 16, fig. 3B-C, non 3A.
1956*b*. *Orbignyna rimosa* (MARSSON); J. HOFKER, Die Pseudotextularia-Zone..., p. 62, pl. 5, fig. 1.
1956*a*. *Orbignyna rimosa* (MARSSON); J. HOFKER, Les Foraminifères..., p. B-201, fig. 54 (non fig. 55-56).

Material. — Some specimens, well preserved.

Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	0·50	0·38
Shortest diameter of test	0·47	0·35

Description. — Test small, spherical, closely coiled, like *Arenobulimina,* early portion not visible. Flattened on facial surface. 4-5 chambers, sutures straight, not very distinct, flush with test surface. Aperture round, rather small, at the base of last formed chamber. Wall smoothly arenaceous with conspicuous fine spiculae imbedded in the agglutination, mostly directed in the length of test.

Remarks. — This species is characterized by the presence of spicules in the test. HOFKER described in 1956 the trimorphic development of this species. In this author's opinion, 3 generations are represented as early as in the Maastrichtian in Belgium and the Netherlands, giving respectively an *Ataxophragmium* structure of test in the A_2 generation, *Arenobulimina* or *Plectina* in the B generation, and *Orbignyna* in A_1 generation. From this point of view, our closely coiled specimens represent A_1 generation.

Distribution. — Very rare in Poland. Found in the Montian of Boryszew, where it is probably derived. Known from Upper Cretaceous of Germany, Limburg, province Lwów (Lvov, U. S. S. R.), Emba region, and Paris Basin.

Genus **BEISSELINA** VOLOSHINOVA & BALAKHMATOVA, 1959

Beisselina aequisgranensis (BEISSEL, 1891)

(Plate I, figs. 4*a-b*; IV, figs. 5*a-b*)

1891. *Lituola aquisgranensis* BEISSEL; J. BEISSEL, Foraminiferen..., p. 12, pl. 3, fig. 1-16.
1953. *Orbignyna aquisgranensis* (BEISSEL); T. BARNARD & F. T. BANNER, Arenaceous Foraminifera..., p. 199, pl. 9, fig. 10.
1959. *Beisselina aequisgranensis* (BEISSEL); M. M. MOSKVIN, Atlas..., p. 94, pl. 2, fig. 1.
1959. *Beisselina aequisgranensis* (BEISSEL); D. M. RAUZER-ČERNOUSOVA & A. V. FURSENKO, Osnovy paleontologii, p. 227, text-pl. 271*a-b*.

Material. — Few specimens, well preserved.

Dimensions of an average specimen (in mm.):

Length of test	1·50
Maximum width of test	1·00

Description. — Test large, conical, round in transverse section, spiral in early portion, elongated in the remainder of test, chambers low, arranged uniserially. Sutures distinct, slightly depressed, the last chamber much larger, inflated, aperture round or oval on the top of last formed chamber. Wall coarsely arenaceous.

Remarks. — BEISSEL (1891) presented the considerable variability of this species. Our specimens do not differ from specimens figured by BEISSEL (fig. 8, pl. 3).

Distribution. — A few specimens have been found in the Danian and in Montian at Bochotnica, in lower part of phosphoritic layer, probably derived. This species is known from the Upper Cretaceous of the Russian Platform, Caucasus, Germany and England.

Genus **PLECTINA** MARSSON, 1878

Plectina? convergens (KELLER, 1935)

(Plate III, fig. 7*a-b*)

1935. *Heterostomella convergens* KELLER; B. M. KELLER, Microfauna der oberen Kreide..., p. 542, pl. 1, fig. 1-2.
1937. *Plectina convergens* (KELLER); N. A. KALININ, Foraminifery melovych otloženij..., p. 18, pl. 1, fig. 11.
1959. *Heterostomella convergens* KELLER; M. M. MOSKVIN, Atlas..., p. 94, pl. 1, fig. 10.
1961. *Plectina convergens* (KELLER); V. S. AKIMEC, Stratigrafija i foraminifery..., p. 102, pl. 7, fig. 1, 2.

Material. — Some specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	1·02
Maximum width of test	0·45

Description. — Test elongated, fusiform, bluntly pointed at both ends, outline lobulate, early portion short, triangular, remainder of test biserially arranged, tending to be uniserially, chambers slightly inflated, up to 5 in number in one row, sutures indistinct in the early portion, flush with surface, limbate in the remainder of test, depressed between last chambers. Aperture simple, round or oval near the top of the last formed chamber. Wall coarsely arenaceous.

Remarks. — In *Plectina convergens*, described by KELLER from Maastrichtian of Donetz Basin, the test is triserial for about three-fourths of its length. Our specimens, which are biserial nearly throughout the test, are not very similar to the holotype. But this species has a considerable variation. KELLER (1935) included also into this species specimens with much deeper sutures and an irregular arrangement of chambers. It seems possible that our specimens belong to the latter forms. Our specimens resemble, on the one hand, *Plectina convergens* KELLER, on the other — *Adhaerentia midwayensis* PLUMMER, 1938. They differ from the latter by not having an uniserial portion of test, only tending to be uniserial like in *Loxostomum*.

Distribution. — Very rare in Montian of Bochotnica, upper part of phosphoritic layer (probably derived). This species occurs in Santonian, Campanian and Maastrichtian in the Crimea, Caucasus and all over East European Platform (Russian Platform).

Family LAGENIDAE CARPENTER, 1862

Genus **ROBULUS** MONTFORT, 1808

Robulus bibensis (MARIE, MS)

(Plate VI, figs. 1*a-b*)

— *Cristellaria bibensis* MARIE; P. MARIE, Foraminifères du Calcaire Pisolithique (in manuscript), pl. 10, fig. 1-2.
1957. *Lenticulina* sp.; K. POŻARYSKA, Lagenidae du Crétacé sup. de Pologne, p. 129, pl. 17, fig. 1.

Material. — Few specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	2·00
Shortest diameter of test	1·50
Thickness of test	0·70

Description. — Test big, sides flat, closely coiled, involute, periphery rounded, chambers numerous, up to 12; last formed chamber of peculiar shape, having a distinct ventral lobe. Chambers gently convex, of rather uniform size and shape. Sutures distinct, strongly limbate, slightly curved and depressed. Facial surface smooth, convex. Aperture big, radiate on the top of last formed chamber. Wall smooth and unornamented.

Variation. — Not known because of scarcity of specimens.

Distribution. — In Danian and Montian of Poland (Bochotnica, Góra Puławska, Sochaczew). In the Calcaire Pisolithique of Paris Basin (P. MARIE, oral information). Not known from the Maastrichtian.

Robulus degolyeri (PLUMMER, 1926)

(Plate VII, fig. 4)

1926. *Cristellaria degolyeri* PLUMMER; H. J. PLUMMER, Foraminifera of the Midway..., p. 97, pl. 7, fig. 7.
1941. *Lenticulina degolyeri* (PLUMMER); L. D. TOULMIN, Eocene small Foraminifera..., p. 580, pl. 78, fig. 29, 30.
1944. *Robulus degolyeri* (PLUMMER); O. L. BANDY, Eocene Foraminifera..., p. 368, pl. 60, fig. 5*a-b*.
1951. *Robulus degolyeri* (PLUMMER) BANDY; J. A. CUSHMAN, Paleocene Foraminifera..., p. 14, pl. 3, fig. 21, 22.
1964. *Robulus degolyeri* (PLUMMER); K. POŻARYSKA, On some Foraminifera..., p. 540, pl. 1, fig. 22.

Material. — 25 specimens, well preserved.
Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	0·95	2·10
Shortest diameter of test	0·85	1·30

Description. — Test large, moderately compressed, a little longer than broad, flattened, peripheral margin keeled. Chambers crescent-shaped, up to 10 in number, greatly increasing in size as added, smooth, sutures distinct, considerably raised, especially in central part of shell, forming high sutural ridges, fusing at the center in a quite irregular but conspicuous boss, tapering outwards to the margin, where they are nearly flush with the surface. Keel narrow, sharp, ragged, transparent, usually broken. Facial surface elongated, convex, bordered by two ribs. Aperture radiate, elongated on the top of last formed chamber.

Variation. — Applies especially to character of central boss which can be in varying degrees irregularly developed, sometimes divided into several tubercles. The boss can be located near inner periphery, or more or less in the middle of test. In our specimens the central boss is never in the centre of test, always somewhat sideways.

Remarks. — Our specimens differ from the holotype, being more elongated.

Distribution. — Common in Montian at Sochaczew, Boryszew and Góra Puławska. Not present in the Danian. Common in Paleocene of U.S.A.

Robulus hornerstownensis OLSSON, 1960

(Plate VIII, figs. 3*a-b*, 4)

1951. *Robulus* cf. *R. rosettus* (GÜMBEL); J. A. CUSHMAN, Paleocene Foraminifera..., p. 16, pl. 4, fig. 20, 21.
1960. *Robulus hornerstownensis* OLSSON; R. K. OLSSON, Foraminifera..., p. 10, pl. 2, fig. 3, 4.

Material. — A hundred or so specimens, well preserved.
Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	0·63	0·50
Shortest diameter of test	0·50	0·40
Thickness of test	0·28	—

Description. — Test small, closely coiled, thick, peripheral margin keeled, outline slightly lobulate, chambers distinctly inflated, few up to 5 in number, increasing rapidly in size as added, slightly convex, smooth. Sutures curved, slightly depressed or flush with surface. Last chamber forming a lobe. Umbo is sometimes formed, rectangular in shape. Keel very narrow, lobate. Facial surface broad, convex, bordered with two not very distinct rims. Aperture radiate on top of last formed chamber, sometimes on a slight neck.

Variation. — Applies to general size and the presence or lack of the umbo.

Remarks. — Our thick specimens do not differ from the holotype described from New Jersey.

Distribution. — Common in the Danian and Montian at Góra Puławska, Sochaczew, Boryszew and Bochotnica. Known widely from the Paleocene of North America. Present in Upper Danian in Denmark (Hvalløse).

Robulus klagshamnensis BROTZEN, 1948

(Plate VIII, figs. 5*a-b*)

1885. *Cristellaria* cf. *clypeiformis* KOENEN; A. KOENEN, Über eine Paläocäne Fauna..., p. 108, pl. 5, fig. 14.
1927. *Cristellaria osnabrugensis* FRANKE; A. FRANKE, Die Foraminiferen und Ostracoden..., p. 27, pl. 2, fig. 14.
1948. *Robulus klagshamnensis* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 41, pl. 7, fig. 1*a-c*, 2*a-b*.
1962. *Robulus klagshamnensis* BROTZEN; E. M. SCHMID, Die Foraminiferenfauna..., p. 325, pl. 1, fig. 4.

Material. — 25 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·81
Shortest diameter of test	0·75
Thickness of test	0·42

Description. — Test large, moderately compressed, sides strongly convex, peripheral margin sharply keeled, chambers crescent-shaped, comparatively few, usually 8 in the last whorl, increasing very gradually in size as added, of rather uniform shape throughout. Sutures fairly distinct, raised, continuing into the umbilical region, curved, more strongly towards periphery, meeting the latter obliquely. Umbo highly rounded, transparent, often divided into small tubercles. Keel well developed, narrow, sharp, showing a slight lobation, lacking on the last formed chamber, transparent. Facial surface triangular, narrow, joining the preceding whorl in a tight contact, overlapping deeply the last whorl. Aperture radiate on the top of last formed chamber. Wall smooth.

Variation. — Rather great, described in detail by BROTZEN (1948, p. 41), mainly applying to number of chambers, raising of sutural ribs and form of peripheral keel.

Remarks. — Our specimens do not differ from the holotype described from Sweden.

Distribution. — Rare. Present only in Danian and Montian at Góra Puławska. In Klagshamn's conglomerate also very rarely to be found. More common in Danish Selandian and Danian (?) of Austria.

Robulus pseudo-mamilligerus (PLUMMER, 1926)

(Plate VII, figs. 1*a-b*)

1926. *Cristellaria pseudo-mamilligera* PLUMMER; H. J. PLUMMER, Foraminifera of the Midway..., p. 98, pl. 7, fig. 11*a-b*.
1951. *Robulus pseudo-mamilligerus* (PLUMMER); J. A. CUSHMAN, Paleocene Foraminifera..., p. 13, pl. 4, fig. 1-5.
?1962. *Robulus pseudo-mamilligerus* (PLUMMER); E. M. SCHMID, Die Foraminiferenfauna..., p. 325, pl. 2, fig. 2.

Material. — 15 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	2·60
Shortest diameter of test	1·90
Thickness of test	0·42

Description. — Test strongly compressed, slightly elongated, peripheral margin keeled. Chambers slightly curved, smooth, 8 in number in the last whorl, sutures distinct, limbate, elevated, tapering outwards from an irregularly developed central boss or from a group of ribs and tubercles. Keel very thick, not high. Facial surface elongated, convex, bordered by two ribs. Aperture radiate on the top of last formed chamber.

Variation. — Mainly in the character of central boss which may be developed as a group of protuberances.

Remarks. — Our specimens have less chambers than the holotype described by PLUMMER and less than all other specimens recorded in America.

Distribution. — Common in Montian at Boryszew, Góra Puławska and Sochaczew. *Robulus pseudo-mamilligerus* (PLUMMER) described by SCHMID (1962, pl. 2, fig. 2) from the Danian of Austria is not similar at all to PLUMMER's holotype. The central plug and width of ragged keel marks it from PLUMMER's holotype and other American specimens. It is rather related to the *Robulus* sp. described by SCHMID in the same paper (1962, pl. 2, fig. 1). Common in Paleocene of North America.

Robulus rancocasensis OLSSON, 1960

(Plate VII, figs. 3*a-b*, 5*a-c*)

1960. *Robulus rancocasensis* OLSSON; R. K. OLSSON, Foraminifera of the latest Cretaceous..., p. 10, pl. 2, fig. 5, 6.

Material. — Some hundred specimens, well preserved.
Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	0·55	0·60
Shortest diameter of test	0·44	0·48
Thickness of test	—	0·31

Description. — Test large, closely coiled, umbonate, circular in outline. Peripheral margin acute or keeled. Chambers very distinct, smooth, 8 in number in the last whorl, of uniform shape, very gradually increasing in size as added. Sutures distinct, slightly curved, flush with the surface, umbo small, rectangular in shape or slightly elevated, forming a transparent, regular plug. Keel small, regular, not ragged. Facial surface triangular, bordered by two rims, slightly convex. Aperture radiate, big, on top of last formed chamber.

Variation. — These forms are very variable, especially in the shape of central plug and in general size.

Distribution. — Very common in Danian as well as in Montian in all studied outcrops and borings of central Poland. Common in Paleocene of North America. Present in Upper Danian in Denmark (Hvalløse).

Robulus turbinatus (PLUMMER, 1926)

(Plate VIII, figs. 1*a-b*)

1926. *Cristellaria turbinata* PLUMMER; H. J. PLUMMER, Foraminifera of the Midway..., p. 93, pl. 7, fig. 4*a-b*.
1951. *Robulus turbinatus* (PLUMMER); J. A. CUSHMAN, Paleocene Foraminifera..., p. 14, pl. 4, fig. 6-9.
1960. *Robulus turbinatus* (PLUMMER); R. K. OLSSON, Foraminifera..., p. 10, pl. 7, fig. 2.

Material. — About 40 specimens. Peripheral margin often damaged.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·30
Shortest diameter of test	0·22
Thickness of test	0·14

Description. — Test moderately compressed, nearly circular, umbonate, peripheral margin sharply keeled. Chambers semi-crescent, few, 8 in number, narrow, smooth. Sutures distinct, strongly raised and very strongly curved, especially towards the periphery. Umbonal area elevated, forming sometimes a regular plug. Keel ragged, transparent. Facial surface small, overlapping deeply the last whorl, bordered by two rims. Aperture big, radiate, on the top of last formed chamber.

Remarks. — Our specimens do not differ from the holotype described from the Midway formation. In general they are very close to *Robulus klagshamnensis* BROTZEN, but their size is twice as small. Chambers not so crescent, sutures not so curved, keel not so broad.

Distribution. — In Danian and Montian at Bochotnica, Góra Puławska, Sochaczew and Pamiętowo. Present in Danian of Denmark, in the Midway formation in Texas and in New Jersey.

Robulus wilcoxensis CUSHMAN & PONTON, 1932

(Plate VII, figs. 2*a-b*; Plate VIII, fig. 2)

1932. *Robulus wilcoxensis* CUSHMAN & PONTON; J. A. CUSHMAN & G. M. PONTON, An Eocene..., p. 52, pl. 7, fig. 3*a-b*.
1941. *Robulus wilcoxensis* CUSHMAN & PONTON; L. D. TOULMIN, Eocene smaller Foraminifera..., p. 579, pl. 78, fig. 24, 25.
1951. *Robulus wilcoxensis* CUSHMAN & PONTON; J. A. CUSHMAN, Paleocene Foraminifera..., p. 15, pl. 4, fig. 17.
1964. *Robulus wilcoxensis* CUSHMAN & PONTON; K. POŻARYSKA, On some Foraminifera..., p. 540, pl. 1, fig. 1-12.

Material. — About 20 specimens, well preserved.
Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	0·25	0·27
Shortest diameter of test	0·17	0·20
Thickness of test	—	0·11

Description. — Test big, moderately compressed, closely coiled, except toward end. Periphery acute, keeled, with angles, slightly nodose, the intervals between forming straight lines, sometimes a few are concave. Chambers 8 or 9 in the last whorl, of rather uniform shape, except the two or three last, which are lobate or elongated. Sutures distinct, gently curved, flush with surface in the early portion, becoming slightly depressed between later chambers. Keel rather small, blunt. Wall smooth, except for the early raised sutures. Aperture radiate.

Variation. — Applies to the shape of the 2 or 3 last chambers, which can be lobate, elongated or even with a slight tendency to uncoil.

Remarks. — Our specimens do not differ from the holotype.

Distribution. — Rare in Montian at Sochaczew, Boryszew and Góra Puławska. Very similar species occurs in Montian of Paris Basin (P. MARIE, oral information).

Robulus sp.

(Plate VI, figs. 3*a-b*)

Material. — Single specimen, damaged at the apertural end.
Dimensions (in mm.):

Longest diameter of test	2·90
Shortest diameter of test	2·30
Thickness of test	1·30

Description. — Test very thick, regularly coiled, generally evolute, convex on both sides, periphery rounded or slightly subacute, chambers few, 8 in number, increasing gently in size as added. A small umbo flush with the surface of chambers. Sutures distinct, strongly curving outwards from central boss, slightly depressed. Broad, smooth facial surface. Aperture big, radiate on the top of last formed chamber. Wall smooth.

Variation. — Not known.

Remarks. — Similar but not so inflated as *Cristellaria (Robulus) semiimpressa* Rss. described from Rugaard in Jutland by REUSS (1866) and FRANKE (1927).

Distribution. — This remarkably distinctive species, quite different from all other species, belonging to *Lenticulina-Robulus* group, is known only from Montian of Sochaczew; probably also from the Montian of Paris Basin (P. MARIE, oral information) and from the Crimea.

Genus **DARBYELLA** HOWE & WALLACE, 1933

Darbyella irregularis POŻARYSKA, 1957

(Plate VIII, figs. 6, 7*a-b*)

1957. *Lenticulina (Darbyella) irregularis* (POŻARYSKA); K. POŻARYSKA, Lagenidae du Crétacé sup. de Pologne p. 124, pl. 16, fig. 1, 3.

Material. — Two dozen or so specimens.
Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	2·00	2·40
Shortest diameter of test	1·30	1·70
Thickness of test	0·40	0·48

Description. — Test large, compressed, sometimes slightly convex on both sides, the first portion coiled, the remainder of test more or less uncoiled. Periphery rounded, lobate. Chambers numerous up to 12, gently increasing in size as added. Sutures distinct, limbate, slightly curved, depressed. Facial surface smooth, convex. Aperture big, radiate on the top of the last formed chamber.

Variation. — Considerable, applies mostly to the size of uncoiled portion of test.

Remarks. — Most specimens belong to the genus *Darbyella*, but some are planispiral and ought to be referred to *Lenticulina*.

Distribution. — The holotype was described from Nasiłów (middle Vistula) from the phosphoritic layer, lying just on the top of Maastrichtian of Danian age (not of Maastrichtian age, as was previously supposed). To be found too in the Montian in Poland (Bochotnica, Sochaczew, Góra Puławska), as well as in Limburg and Paris Basin (P. MARIE, oral information).

Genus **PLANULARIA** DEFRANCE, 1824

Planularia bzurae POŻARYSKA, 1957

(Plate V, figs. 6*a-c*; Plate VI, figs. 2*a-b*)

partly 1948. *Robulus discus* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 42.
1957. *Planularia pulavensis bzurae* POŻARYSKA; K. POŻARYSKA, Lagenidae du Crétacé sup. de Pologne, p. 104, pl. 19, fig. 5*a-b*.
1957. *Planularia pulavensis bzurae* POŻARYSKA; F. BROTZEN & K. POŻARYSKA, The Paleocene in central Poland, p. 274.
1964. *Planularia bzurae* POŻARYSKA; K. POŻARYSKA, On some Foraminifera..., p. 543, pl. 1, fig. 23; pl. 2, fig. 1-16.

Material. — About one hundred of specimens, well preserved.
Dimensions of 4 specimens (in mm.):

	1	*2*	*3*	*4*
Longest diameter of test	2·00	2·80	3·20	3·65
Shortest diameter of test	1·95	2·10	1·90	2·35
Thickness of test	0·50	0·30	0·62	0·60

Description. — Test large, sides flattened, coiled evolute. Periphery truncate, with well developed keel, dividing sometimes into 3 parallel ragged keels. Chambers numerous, up to 12 in number, slightly convex, sutures distinct, curved, raised, depressed between two last chambers. On the surface some ribs irregularly crossing through sutures and chambers, gradually becoming nearly parallel to the outer edge of the test. Umbo distinctly elevated, sometimes with a small, transparent plug. Facial surface elongated, very narrow, bordered by two thick rims. Aperture radiate, on the top of the last formed chamber.

Variation. — Considerable in the character of peripheral margin which may be more keeled or less, as well as in ornamentation of surface. Ribs can be well developed or only as single, fine costae, crossing sutures, sometimes a solitary ridge appearing here and there (see POŻARYSKA, 1964, pl. 2, fig. 1-16).

Remarks. — This species is related to *Planularia pulavensis* on the one hand, and to *P. discus* on the other. Sometimes it is rather difficult to decide to which of them the studied specimens belong.

Distribution. — Found neither in Maastrichtian, nor in Danian. Common in Montian of Poland, as well as in Selandian of Sweden.

Planularia discus (BROTZEN, 1948)

(Plate V, figs. 5*a-c*)

1948. *Robulus discus* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 42, pl. 7, fig. 3, 4, text-fig. 7.
1957. *Planularia pulavensis umbonata* POŻARYSKA; K. POŻARYSKA, Lagenidae du Crétacé sup. de Pologne, p. 103, pl. 19, fig. 4.

Material. — Some hundred specimens, well preserved.
Dimensions of 4 specimens (in mm.):

	1	*2*	*3*	*4*
Longest diameter of test	1·12	1·65	2·15	2·60
Shortest diameter of test	0·90	1·22	1·75	1·90
Thickness of test	0·45	0·57	0·70	0·80

Description. — Test large, compressed, sides flat, umbo in the central part of test strongly elevated. Peripheral margin keeled, with the exception of last chamber. Chambers numerous, up to 13 in number, gently increasing in size as added, slightly convex. Sutures very distinct, transparent, thick, depressed between two last chambers. Proloculum with a central plug and some irregular ribs. Facial surface narrow, elongated, bordered by two rims. Aperture radiate on the top of last formed chamber.

Variation. — Very great. Test can be less inflated, keel more developed or less, central plug sometimes big, sometimes smaller.

Remarks. — Some of our specimens are the same as the holotype described by BROTZEN (1948). *Planularia dissona* (PL.), described from America, seems to be very similar to *P. discus* (BROTZEN).

Distribution. — Common in the Danian and Montian of Poland. Never in the Maastrichtian. Rare in Klagshamn's conglomerate, as well as in the Danish Upper Danian and Selandian.

Planularia pulavensis POŻARYSKA, 1957, emend. 1965

(Plate V, figs. 4*a-c*)

1957. *Planularia pulavensis pulavensis* POŻARYSKA; K. POŻARYSKA, Lagenidae du Crétacé sup. de Pologne, p. 102, pl. 19, fig. 6.

pars 1948. *Robulus discus* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 42, pl. 7, fig. 5.

1964. *Planularia pulavensis* POŻARYSKA; K. POŻARYSKA, On some Foraminifera..., pl. 1, fig. 24.

Material. — Some hundred specimens, well preserved.

Dimensions of 4 specimens (in mm.):

	1	*2*	*3*	*4*
Longest diameter of test	1·12	1·65	2·15	2·80
Shortest diameter of test	0·90	1·22	1·75	2·10
Thickness of test	0·45	0·57	0·70	0·40

Description. — Test large, strongly compressed, sides flat, periphery rounded, sometimes slightly keeled, coiled evolute; all coils, including proloculum, visible. Chambers numerous, up to 15 in number. Width of chambers increasing gradually as the test develops. Sutures distinct, slightly depressed, transparent, gently curved. The facial surface narrow, elongated, limbate, with 2 distinct sutures, somewhat raised. Aperture big, radiate, on the top of the last formed chamber. Wall smooth, polished.

Variation. — Applies to the general shape and size only.

Remarks. — Our specimens from borings do not differ from the holotype.

Distribution. — Very common in Danian and Montian of Poland (Boryszew, Góra Puławska, Sochaczew, Żyrzyn). Not known from the Maastrichtian. The holotype was erroneously described as being from the Maastrichtian (POŻARYSKA, 1957), as the phosphoritic layer lying just on the top of the »opoka« limestone, is of Danian age, containing *Globigerina daubjergensis* BRONN.

Genus **MARGINULINA** D'ORBIGNY, 1826

Marginulina costulata HOFKER, 1958

(Plate IX, figs. 1-2)

1944. *Marginulina species* TEN DAM; A. TEN DAM, Die stratigraphische Gliederung..., p. 99, pl. 6, fig. 6.

1951. *Marginulina* sp. *B*; J. A. CUSHMAN, Paleocene Foraminifera..., p. 18, pl. 5, fig. 32-33.

1957. *Marginulina* cf. *armata* REUSS; K. POŻARYSKA, Lagenidae du Crétacé sup. de Pologne, p. 105, pl. 11, fig. 13.

1958. *Marginulina costulata* HOFKER; J. HOFKER, Foraminifera from the Cretaceous..., XXXIV, p. 66, text-fig. 10*a-b*.

Material. — Some dozens of specimens, well preserved.
Dimensions of 2 specimens (in mm.):

	1	*2*
Length of test	0·55	0·70
Maximum width of test	0·22	0·21

Description. — Test small, delicate, short, elongated in a straight line up to 5 chambers only. Chambers low, sometimes about twice as broad as long, slightly swollen, round in section. Sutures indistinct, depressed, transverse. Proloculum rather big, initial end with a slight spine. Longitudinal, continuous striae running throughout the chamber surfaces as well as through suture depressions. Sometimes fine tubercles coalescing into fine ribs, the last formed chamber with fine spines. Aperture big, radiate, placed asymmetrically.

Variation. — In the character of ribs, varying from small striae to isolated tubercles, arranged in a straight line.

Remarks. — This small species of *Marginulina costulata* is very characteristic for Danian, and especially for Montian strata in Poland.

Distribution. — Rare in Danian (Bochotnica, Sochaczew, Góra Puławska), common in Montian (Boryszew, Sochaczew, Pamiętowo). It occurs in uppermost Cretaceous (*Md*) and in Danian in Limburg.

Marginulina cf. **plummerae** CUSHMAN, 1937

(Plate IX, fig. 9)

1937. *Marginulina plummerae* CUSHMAN; J. A. CUSHMAN, Some notes..., p. 97, pl. 13, fig. 21-23.
1957. *Marginulina plummerae* CUSHMAN; K. POŻARYSKA, Lagenidae du Crétacé sup. de Pologne, p. 110, pl. 13, fig. 5.
1964. *Marginulina* cf *plummerae* CUSHMAN; K. POŻARYSKA, On some Foraminifera..., p. 545, pl. 5, fig. 1-12.

Material. — Some dozens of specimens, often damaged.
Dimensions of 3 specimens, well preserved (in mm.):

	1	*2*	*3*
Length of test	0·70	1·05	1·62
Maximum width of test	0·30	0·32	0·42
Thickness of test	0·22	0·25	0·40

Description. — Test elongated, compressed, especially in early portion which is coiled. Very early becoming uncoiled and gradually less compressed until the section becomes nearly circular. One side nearly straight, last slightly convex, the other side slightly concave. Chambers few in coiled portion, in uncoiled portion gradually increasing in size as added, of rather uniform shape, the last becoming distinctly inflated, subspherical, sutures distinct, slightly oblique, in the first portion of test flush with the surface, in the remainder of test, especially between 3 last chambers, depressed. Aperture radiate, asymmetrical, sometimes on an elongated, tapering neck. Wall smooth.

Variation. — Rather small, in the curvature of test axis only.

Remarks. — Some specimens described by CUSHMAN (1946, pl. 22, fig. 7, 8) seem not to belong to this species. Raised sutures in the middle portion of test and broader chambers are characteristic features for some *Vaginulina* species, for instance *V. longiforma* (PLUMMER) and *V. earlandi* (PLUMMER).

Distribution. — Common in Danian as well as in Montian in all studied outcrops and borings, except Pamiętowo. This species occurs in Maastrichtian and Danian at Limburg, and probably in Montian of Paris Basin (P. MARIE, oral information). Known from the Upper Cretaceous of North America.

Marginulina sp.

(Plate VI, fig. 5)

Material. — Some specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·85
Maximum width of test	0·30

Description. — Test composed of 3-4 chambers, the first being the longest. Chambers strongly inflated, suture not distinct, but deeply depressed, the initial end acute, aperture radiate on the elongated top of last formed chamber, lying somewhat asymmetrical. Chambers covered by numerous, minute ribs, like striae, extending throughout the test.

Remarks. — Similar to *Dentalina multicostata* D'ORBIGNY from Cretaceous of Paris Basin.

Distribution. — Rare in Montian at Magnuszew and Żyrzyn (probably derived).

Genus **DENTALINA** D'ORBIGNY, 1826

Dentalina vistulae POŻARYSKA, 1957

(Plate VI, figs. 6, 7)

1926. *Nodosaria longiscata* D'ORBIGNY; H. J. PLUMMER, Foraminifera of the Midway..., p. 82, pl. 4, fig. 17*a-b*.
1951. *Nodosaria* cf. *longiscata* D'ORBIGNY; J. A. CUSHMAN, Paleocene Foraminifera..., p. 24, pl. 7, fig. 9, 10.
1957. *Dentalina vistulae* POŻARYSKA; K. POŻARYSKA, Lagenidae du Crétacé sup. de Pologne, p. 89, pl. 7, fig. 10, text-fig. 18.
1960. *Nodosaria*? cf. *longiscata* D'ORBIGNY; R. K. OLSSON, Foraminifera..., p. 18.

Material. — Some dozens of specimens, almost always damaged.
Dimensions of 2 specimens, representing two generations (in mm.):

	1	*2*
Length of test	0·7	1·4
Diameter of proloculum	0·23	0·37 and 0·15
Maximum width of chamber	0·12	0·14
Length of chamber	0·48	0·65

Description. — Test very long, slender, pipe-like, chambers numerous, cylindrical to ellipsoidal, exceptionally elongated, circular in transverse section, sutures not very distinct, slightly depressed. Proloculum big, round, circular in some specimens, elongated like following

chambers in other specimens. Chambers like sticks, only very slightly inflated in the middle. Wall smooth, aperture small radiate on a short neck.

Variation. — Insignificant.

Remarks. — Generally known from fragments. Entire specimens very difficult to procure. This species described by the present writer (1957) resembles at the first glance *Nodosaria longiscata* D'ORBIGNY, 1846, but differing from the latter in general size which is much smaller, being a more delicate test, porcellaneous not opaque, and chambers not swollen, not angular at the base. These observations are in agreement with PLUMMER (1926). The holotype of *N. longiscata* D'ORBIGNY, defined by this author from the Miocene of Vienna Basin, is showing distinct angulations at the base of each chamber. So it is better not to extend D'ORBIGNY's definition to forms with elongate chambers, not swollen at base, and the more so as these two forms do not occur in the same period. *Dentalina vistulae* POŻARYSKA appears with the beginning of Danian, whereas *Nodosaria longiscata* D'ORBIGNY — in Miocene. Specimens described by PLUMMER (1926) ought to belong to *Dentalina vistulae* POŻARYSKA, and not to *Nodosaria longiscata* D'ORB. Our specimens similar to *Siphonodosaria exilis* (NEUGEBOREN), described by SUBBOTINA (1953a) from Upper Eocene of the Crimea.

Distribution. — Common in Danian and Montian at Bochotnica, Góra Puławska, Sochaczew and Żyrzyn. All the intraspecific discussion is given in the quoted paper (POŻARYSKA, 1957).

Dentalina annloomisae McLEAN, 1951

(Plate XI, figs. 5-7)

1951. *Dentalina annloomisae* McLEAN; J. D. McLEAN, Paleocene Foraminifera..., p. 25, pl. 4, fig. 6-7.
1957. *Dentalina annloomisae* McLEAN; K. POŻARYSKA, Lagenidae du Crétacé sup. de Pologne, p. 74, pl. 8, fig. 3.

Material. — 70 specimens, often damaged.
Dimensions of 5 specimens well preserved (in mm.):

	A — form			B — form	
	1	*2*	*3*	*4*	*5*
Length of test	3·80	4·55	7·95	8·55	8·70
Maximum width of test	0·50	0·80	0·85	0·92	0·70
Diameter of proloculum	0·30	0·52	0·35	0·12	0·12

Description. — Test large, elongated, arcuate, with a tapering initial end in the microspheric form and an enlarged initial chamber with a small initial spine in the megalospheric form. Chambers numerous, up to 11, in the early portion obscured in both generations by heavy, longitudinal ridges. Chambers slightly inflated in the early portion, more inflated in the remainder of test. Sutures limbate, depressed, indistinct. Aperture radiate, protruding, on the top of last formed chamber. Wall smooth, glistening.

Variation. — Not considerable. It applies mainly to the general shape, which is more arcuate or less, up to almost straight.

Remarks. — Our specimens differ from the holotype in not having sutures so developed that they could be defined as distinct, constricted bands (McLEAN, 1951). They are rather indistinct.

Distribution. — Common in Montian at Boryszew and Góra Puławska.

Genus **NODOSARIA** LAMARCK, 1812

Nodosaria granti PLUMMER, 1926

(Plate VI, fig. 8)

1926. *Nodosaria granti* PLUMMER; H. J. PLUMMER, Foraminifera of the Midway..., p. 83, pl. 5, fig. 9*a-d*.

Material. — A hundred or so specimens.
Dimensions of an average specimen (in mm.):

Length of test	5·30
Maximum width of test	0·50

Description. — Test very long, slender, straight or gently arcuate, smooth. Length up to several millimetres. Chambers numerous, over 10, somewhat swollen, pyriform or cylindrical, round in section, twice as long as broad, sutures indistinct, transverse, depressed. Wall thick, opaque. Proloculum rather small, apiculate. Aperture radiate.

Variation. — Considerable, applying mainly to length of chambers and to curvature of the test axis, illustrated excellently by PLUMMER (1926).

Remarks. — Our specimens are very similar to those described by PLUMMER from Midway formation.

Distribution. — Common in Danian as well as in Montian, at Bochotnica, Góra Puławska, Nasiłów, Sochaczew and Żyrzyn. Not known in the Maastrichtian. Very common in the basal strata of the Midway formation.

Genus **SARACENARIA** DEFRANCE, 1824

Saracenaria hamata (FRANKE, 1927)

(Plate VI, figs. 4*a-b*)

1927. *Cristellaria hamata* FRANKE; A. FRANKE, Foraminiferen und Ostracoden..., p. 24, pl. 2, fig. 12*a-c*.
1951. *Marginulina* cf. *hamata* (FRANKE) CUSHMAN & TODD; J. A. CUSHMAN, Paleocene Foraminifera..., p. 18, pl. 5, fig. 28-29.
1957. *Saracenaria hamata* FRANKE; K. POŻARYSKA, Lagenidae du Crétacé sup. de Pologne, p. 118, pl. 10, fig. 9*a-b*.

Material. — 10 specimens, well preserved.
Dimensions of 4 specimens (in mm.):

	1	*2*	*3*	*4*
Height of test	1·65	1·70	1·85	2·55
Maximum width of test	0·70	1·10	1·00	1·15
Thickness of test	0·40	0·40	0·50	0·60

Description. — Test big, elongated, keeled, early portion closely coiled, somewhat compressed, becoming uncoiled in the remainder of test, axis slightly curved. Uncoiled portion triangular in the section. Chambers curved, numerous, up to 14 in number, distinctly inflated, smooth, of uniform shape as added. Sutures distinct, depressed, gently curved, limbate and raised in the early portion, tapering outwards. Keel narrow, transparent, ragged. Facial surface triangular, strongly convex, bordered by two rims. Aperture big, radiate.

Variation. — Applies to length and thickness of uncoiled portion. All the other features the same.

Remarks. — Our specimens somewhat narrower than the holotype.

Distribution — Rare. Known from the Montian of Bochotnica, Góra Puławska and Sochaczew, and from the Paleocene of Jutland. Not known from the Danian.

Genus **SVENIA** BROTZEN, 1937

Svenia megalopolitana (REUSS, 1855)

(Plate IX, fig. 8)

1855. *Dentalina megalopolitana* REUSS; A. E. REUSS, Ein Beitrag zur genaueren Kenntnis der Kreidegebilde Mecklenburgs, p. 267, pl. 8, fig. 10.
1925. *Nodosaria megalopolitana* REUSS; A. FRANKE, Die Foraminiferen der pommerschen Kreide, p. 33, pl. 3, fig. 8.
1931. *Dentalina megalopolitana* REUSS; J. A. CUSHMAN, Foraminifera of Tennessee, p. 29, pl. 3, fig. 8.
1946. *Dentalina megalopolitana* REUSS; J. A. CUSHMAN, Upper Cretaceous Foraminifera..., p. 67, pl. 23, fig. 24-26.
1957. *Dentalina megalopolitana* REUSS; K. POŻARYSKA, Lagenidae du Crétacé sup. de Pologne, p. 84, pl. 7, fig. 12-13, text-fig. 17.
1958. *Dentalina megalopolitana* REUSS; J. HAYNES, Certain smaller..., p. 66, pl. 16, fig. 8.

Material. — Some dozens of specimens, often damaged.
Dimensions of 4 specimens, well preserved (in mm.):

	A — form		B — form	
	1	*2*	*3*	*4*
Length of test	2·40	2·90	1·85	1·25
Maximum width of test	0·30	0·45	0·25	0·25
Diameter of proloculum	0·13	0·15	0·05	0·15

Description. — Test elongated, tapering, slightly fusiform, axis of test gently curved, greatest width developed before the last formed chamber. Chambers numerous, up to 13 in number, not inflated, of uniform shape, gradually increasing in size as added, sutures distinct, straight, flush with surface, slightly depressed, but only between three last chambers. Aperture radiate, on the top of last formed chamber. Wall smooth.

Variation. — Not considerable. A very distinctive species.

Remarks. — Our specimens do not differ from the holotype described by REUSS (1855) from Turonian.

Distribution. — Common in Upper Cretaceous and in Lower Tertiary in almost all studied samples. Known from Upper Cretaceous of Europe as well as North America and Australia.

Genus **PSEUDOGLANDULINA** CUSHMAN, 1929

Pseudoglandulina parallela (MARSSON, 1878)

(Plate IX, figs. 4, 5)

1878. *Glandulina parallela* MARSSON; T. MARSSON, Die Foraminiferen..., pl. 1, fig. 4*a-b*.
1900. *Glandulina parallela* MARSSON; J. G. EGGER, Foraminiferen und Ostracoden aus den Kreidemergeln der Oberbayerischen Alpen, p. 83, pl. 5, fig. 25.
1957. *Pseudoglandulina parallela* (MARSSON); K. POŻARYSKA, Lagenidae du Crétacé sup. de Pologne, p. 94, pl. 9, fig. 5.

Material. — Few specimens, well preserved.
Dimensions of 4 specimens (in mm.):

	1	*2*	*3*	*4*
Length of test	0·85	2·40	1·25	0·90
Maximum width of test	0·36	0·70	0·65	0·50

Description. — Test short and stout, initial end broadly rounded, circular in transverse section, chambers few, as long as broad, much overlapping. Sutures fairly distinct, straight, very slightly depressed. Aperture radiate, projecting on the top of last formed chamber. Wall thick, smooth, porcellaneous.

Remarks. — Our specimens do not differ from the holotype described from Upper Cretaceous of Germany.

Distribution. — Very rare in Montian at Boryszew. Probably derived.

Genus **TRISTIX** MACFADYEN, 1941

Tristix excavatus (REUSS, 1863)

(Plate XI, figs. 4*a-b*)

1863. *Rhabdogonium excavatum* REUSS; A. E. REUSS, Die Foraminiferen-Familie der Lagenideen, p. 91, pl. 12, fig. 8*a-c*.
1925. *Rhabdogonium excavatum* REUSS; A. FRANKE, Die Foraminiferen der pommerschen Kreide, p. 53, pl. 4, fig. 20*a-c*.
1961. *Tristix excavatus* (REUSS); V. S. AKIMEC, Stratigrafija i foraminifery..., p. 107, pl. 8, fig. 3-4 (earlier synonymy included).

Material. — 10 specimens, half of them damaged.
Dimensions of an average specimen (in mm.):

Length of test	0·63
Maximum width of test	0·32

Description. — Test delicate, elongated, triangular in transverse section, peripheral margins acute, sides flat or slightly convex, tapering toward both ends, which are acute. Chambers semicrescent, of uniform shape, moderately increasing in size as added, sutures distinct, gently curved, flush with surface. Aperture small, round on the top of test. Wall thin, transparent.

Variation. — Insignificant.

Remarks. — Our specimens differ from the holotype, described from Kent, in not having concave sides, but rather flat or even slightly convex.

Distribution. — Rare in Danian and Montian at Góra Puławska and Boryszew, where they are probably derived.

Genus **LINGULINA** D'ORBIGNY, 1826

Lingulina naheolensis CUSHMAN, 1947

(Plate XI, figs. 2*a-b*)

1947. *Lingulina naheolensis* CUSHMAN; J. A. CUSHMAN, Lingulina..., p. 18.
1951. *Lingulina naheolensis* CUSHMAN; J. A. CUSHMAN, Paleocene Foraminifera..., p. 26, pl. 7, fig. 23.

Material. — Single specimen, well preserved.
Dimensions (in mm.):

Length of test	0·48
Maximum width of test	0·23

Description. — Test minute, fusiform, about twice as long as broad, compressed, tapering toward both ends which are acute, greatest breadth about the middle, chambers few, 6 in number, crescent, strongly overlapping, increasing rapidly in size as added, sutures distinct, flush with surface, meeting obliquely with the periphery. Aperture terminal, radiate. Wall smooth.

Remarks. — Our specimen has slightly more curved sutures, while the American specimen figured by CUSHMAN (1947, 1954) has nearly straight sutures at right angles to the long axis of test.

Distribution. — Single specimen has been found in Montian at Boryszew. This species is known from the Paleocene of North America.

Lingulina? sp.

(Plate XI, figs. 3*a-b*)

Material. — One specimen, well preserved.
Dimensions (in mm.):

Length of test	0·70
Maximum width of test	0·30
Thickness of test	0·18

Description. — Test elongated, moderately tapering, compressed, peripheral margin broadly rounded and lobulate. Chambers numerous, inflated on every side of axial depression, which extends throughout the test. Proloculum distinct, circular. Sutures distinct, depressed. Aperture, an elongated, narrow slit on the top of last formed chamber. Wall smooth.

Distribution. — Danian. Bochotnica quarry.

Genus **VAGINULINA** D'ORBIGNY, 1826

Vaginulina earlandi (PLUMMER, 1926)

(Plate IX, figs. 7*a-b*; Plate X, figs. 2*a-b*)

1926. *Cristellaria earlandi* PLUMMER; H. J. PLUMMER, Foraminifera of the Midway..., p. 103, pl. 7, fig. 10.

Material. — About 40 specimens. The uncoiled portion of test often damaged.
Dimensions of 2 specimens (in mm.):

	1	*2*
Length of test	0·37	0·48
Maximum width of test	0·18	0·10

Description. — Test elongated, broad, compressed, elliptical in section, early portion more or less coiled, but only a few early chambers are coiled in form *A*, much more in form *B*, the remainder of test elongated in a straight line or somewhat oblique. Chambers low, three

times or twice as broad as high, sutures distinct, oblique, strongly limbate, raised on each side, appearing on margins as lines or less distinct ridges. Wall smooth. Aperture radiate, asymmetrical, on an elongated, tapering neck.

Variation. — Mainly in the curvature of the axis of elongated portion of test.

Remarks. — In our specimens sutures not so strongly raised as in the holotype presented by PLUMMER (1926).

Distribution. — Common in Danian as well as in Montian at Góra Puławska, Sochaczew and Pamiętowo. Known from the London Clay in England.

Vaginulina gladius (PHILIPPI, 1843)

(Plate IX, figs. 6*a-b*)

1843. *Marginulina gladius* PHILIPPI; R. A. PHILIPPI, Beiträge zur Kenntnis..., p. 40, pl. 1, fig. 37.
1856. *Cristellaria gladius* PHIL. sp.; A. E. REUSS, Beiträge zur Charakteristik..., p. 38, pl. 2, fig. 31*a-b*.
1927. *Cristellaria gladius* PHIL.; A. FRANKE, Die Foraminiferen und Ostracoden..., p. 22, pl. 2, fig. 6*a-b*.

Material. — About 20 specimens.
Dimensions of an average specimen (in mm.):

Lenght of test	0·55
Maximum width of test	0·25

Description. — Test elongated, broad, elliptical in section, early portion can be more tightly coiled or less, the remainder of test elongated. Chambers numerous, of uniform size as added, about twice as broad as high, sutures distinct but quite flush with surface. Aperture radiate, asymmetrical, lying near the margin. Wall smooth.

Variation. — Only in the breadth of chambers, and consequently of test.

Remarks. — Our specimens do not differ from the holotype. Rather more slender than these described by FRANKE from Rugaard (1927).

Distribution. — Common in Danian and in Montian at Bochotnica, Góra Puławska, Sochaczew and Pamiętowo.

Vaginulina sp.

(Plate IX, fig. 3)

1951. *Vaginulina* sp.; J. A. CUSHMAN, Paleocene Foraminifera..., p. 29, pl. 8, fig. 19.

Material. — Few specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	2·30
Maximum width of test	0·50

Description. — Test like *Marginulina plummerae* CUSHMAN, chambers about twice as broad as high, somewhat broader than in *M. plummerae*, in the section not so round, rather elliptical. Ornamentation throughout surface, with numerous, fine, longitudinal slightly oblique costae.

Variation. — Not known, due to scarcity of material.

Distribution. — Very rare, only few specimens in Montian at Boryszew boring. Some few identical specimens were mentioned by CUSHMAN (1951), but not described because of scarcity and poverty of material.

Genus **ASTACOLUS** MONTFORT, 1808

Astacolus arcuatus (PHILIPPI, 1843)

(Plate X, figs. 6*a-b*)

1843. *Marginulina arcuata* PHILIPPI; R. A. PHILIPPI, Beiträge zur Kenntnis..., p. 5, pl. 1, fig. 28.
1927. *Cristellaria arcuata* PHIL.; A. FRANKE, Die Foraminiferen und Ostracoden..., p. 22, pl. 2, fig. 7 (earlier synonymy included).

Material. — Some dozens of specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·60
Maximum width of test	0·35
Thickness of test	0·10

Description. — Test broad, sides flattened, elongated, slightly arched, periphery truncated, gently rounded. Chambers numerous in coiled portion, up to 10 in number, only few in uncoiled portion. Chambers very broad and low, slightly increasing in size as added, of rather uniform shape. The breadth of chambers in uncoiled portion is about the same as the breadth of coiled portion. Sutures raised, limbate, gently curved, the last ones strongly oblique, parallel. Facial surface just below the top of the last formed chamber. Surface smooth, except for raised sutures.

Variation. — This species does not vary.

Remarks. — Similar species is known from the Cretaceous — *Astacolus tricarinella* (Rss.). Our specimens are more compressed than the holotype. Other features the same. Do not differ from the Danish specimens described by FRANKE (1927).

Distribution. — Common in Danian as well as in Montian at Bochotnica, Góra Puławska, Sochaczew and Pamiętowo. Known from Germany and Denmark.

Astacolus gryi BROTZEN, 1948

(Plate X, figs. 1*a-b*)

1948. *Astacolus gryi* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 44, pl. 7, fig. 6*a-c*.
1957. *Astacolus gryi* BROTZEN; F. BROTZEN & K. POŻARYSKA, The Paleocene in central Poland, p. 274.
1958. *Astacolus gryi* BROTZEN; J. HOFKER, Foraminifera from the Cretaceous..., p. 64, pl. 34, text-fig. 1*a-b*.
1963. *Lenticulina (Astacolus) gryi* BROTZEN; O. K. KAPTARENKO-ČERNOUSOVA *et al.*, Atlas..., p. 135, pl. 29, fig. 4.
1964. *Astacolus gryi* BROTZEN; K. POŻARYSKA, On some Foraminifera..., p. 540, pl. 1, fig. 20-21.

Material. — 25 specimens, well preserved.
Dimensions of 4 specimens (in mm.):

	1	*2*	*3*	*4*
Length of test	1·85	2·37	2·55	2·80
Maximum width of test	1·05	1·30	1·35	1·80
Thickness of test	0·30	0·35	0·45	—

Description. — Test large, elongated, inflated, coiled portion biconvex, periphery truncated on ventral side, keeled on dorsal side. Chambers numerous, but only few in the coiled portion, increasing gradually in size and breadth as added, low, sometimes broader than high. Sutures distinct, raised, slightly curved, with single tubercles in the beginning, later with rows of tubercles along sutures. Some specimens have irregularly crossing ribs in coiled portion near inner periphery. Keel narrow, sharp, rugged. Facial surface very narrow and very long, bordered by two distinct ribs. Aperture big, radiate at outer peripheral angle.

Variation. — Applies to character of ornamentation.

Remarks. — The species discussed by BROTZEN (1948).

Distribution. — Rare in Montian at Bochotnica, Boryszew, Góra Puławska, Magnuszew, Nasiłów and Sochaczew. Present in the Paleocene of Denmark, Sweden and in south regions of U. S. S. R.

Astacolus cf. **havanensis** (CUSHMAN & BERMUDEZ, 1937)

(Plate X, figs. 3-5)

1951. *Marginulina* cf. *havanensis* CUSHMAN & BERMUDEZ; J. A. CUSHMAN, Paleocene Foraminifera..., p. 18, pl. 5, fig. 24.

Material. — Some dozens of specimens. Last chambers often damaged.
Dimensions of 3 specimens (in mm.):

	1	*2*	*3*
Length of test	1·60	1·60	2·00
Maximum width of test	0·70	0·50	0·70

Description. — Test large, compressed, closely coiled in early portion, later portion becoming uncoiled. Periphery entire not lobulate. Chambers distinct, increasing regularly in size as added, those of uncoiled portion sometimes reduced in size, variable in number. Sutures distinct, except coiled portion, where they are flush with surface slightly depressed and somewhat curved. Wall smooth. Aperture big, radiate, on the top of last formed chamber.

Variation. — Mainly in size of uncoiled portion.

Remarks. — Our specimens differ from the American ones in not having lobulated periphery.

Distribution. — Common in Danian as well as in Montian at Bochotnica, Góra Puławska, Nasiłów, Sochaczew and Żyrzyn.

Astacolus paleocenicus BROTZEN, 1948

(Plate X, fig. 9)

1948. *Astacolus paleocenicus* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 43, pl. 7, fig. 7*a-b*, text-fig. 8.
1957. *Astacolus palaeocenicus* BROTZEN; F. BROTZEN & K. POŻARYSKA, The Paleocene in central Poland, p. 274.

Material. — A dozen or so specimens, often damaged.
Dimensions of 2 specimens (in mm.):

	1	*2*
Length of test	1·00	3·20
Maximum width of test	0·67	1·60

Description. — Test large, flattened, strongly elongated, only few chambers coiled, periphery truncated on ventral, keeled on dorsal side. Chambers numerous, very broad, low, of uniform shape and size as added, in some cases reduced size in the last chambers. Sutures curved, limbate, slightly raised. Wall with numerous raised ridges, running throughout all chambers and sutures, often interrupted over the sutures, disappearing toward the apertural end. Keel narrow, ragged, sharp. Aperture radiate at outer peripheral angle.

Variation. — Not great, described by BROTZEN (1948).

Remarks. — Our specimens do not differ from the holotype described by BROTZEN (1948). This species resembles *Astacolus gryi* BROTZEN in shape, but is much larger; it differs also in ornamentation.

Distribution. — Not very common in Danian at Sochaczew, common in Montian at Bochotnica, Boryszew, Nasiłów, Pamiętowo and Sochaczew. Known from Swedish Paleocene and Danish Upper Danian.

Astacolus cf. **trigonatus** (PLUMMER, 1926)

(Plate X, figs. 7*a-b*, 8)

1926. *Cristellaria trigonata* PLUMMER; J. H. PLUMMER, Foraminifera of the Midway..., p. 101, pl. 7, fig. 3*a-b*
1957. *Astacolus* sp.; K. POŻARYSKA, Lagenidae du Crétacé sup. de Pologne, p. 101, pl. 13, fig. 9*a-b*.
1957. *Astacolus* cf. *cretaceus* (CUSHMAN); F. BROTZEN & K. POŻARYSKA, The Paleocene in central Poland, p. 274
1958. *Saracenaria trigonata* (PLUMMER); J. HOFKER, Foraminifera from the Cretaceous..., p. 65, pl. 34, text-fig. 8*a-b*

Material. — About 25 specimens, often damaged.

Dimensions of 3 specimens (in mm.):

	1	*2*	*3*
Length of test	1·28	1·30	1·35
Maximum width of test	0·56	0·62	0·55
Thickness of test	0·24	—	—

Description. — Test much compressed, very broad, gently tapering, early portion coiled, later portion uncoiled. Periphery rounded, not lobulate, dorsal side convex, ventral slightly concave. Chambers numerous, distinct, increasing gradually in size and breadth as added, not inflated. Sutures distinct, slightly curved, flush with surface. Wall smooth. Aperture radiate at the outer peripheral angle, on a short, tapering neck.

Variation. — Only in general shape, less or more slender.

Remarks. — General features make this species very similar to *Astacolus cretaceus* (CUSHMAN). It differs in general shape, tapering, not rounded. Our specimens differ from the holotype, being not so thick and not triangular in transverse section.

Distribution. — Not very common in Danian and Montian at Bochotnica, Boryszew, Góra Puławska, Nasiłów, Sochaczew and Żyrzyn.

Genus **PALMULA** LEA, 1833

Palmula elliptica (NILSSON, 1827)

(Plate V, figs. 2, 3)

1827. *Planularia elliptica* NILSSON; S. NILSSON, Petrefacta Suecana, p. 11, pl. 9, fig. 21, 22.
1878. *Flabellina elliptica* (NILSS.); T. MARSSON, Die Foraminiferen..., p. 138.
1936. *Flabellina elliptica* (NILSSON); F. BROTZEN, Foraminiferen aus dem schwedischen untersten Senon von Eriksdal in Schonen, p. 105, pl. 7, fig. 14-15, text-pl. 33-34 (earlier synonymy included).

1946. *Palmula elliptica*? (NILSSON); J. A. CUSHMAN, Upper Cretaceous Foraminifera..., p. 85, pl. 32, fig. 17.
1954. *Palmula elliptica* (NILSSON); K. POŻARYSKA, O przewodnich otwornicach..., p. 256, fig. 10.
1957. *Palmula elliptica* (NILSSON); K. POŻARYSKA, Lagenidae du Crétacé sup. de Pologne, p. 166, pl. 25, fig. 4.

Material. — Some hundred specimens, some of them damaged.
Dimensions of 4 specimens well preserved (in mm.):

	1	*2*	*3*	*4*
Length of test	4·50	5·35	6·00	8·35
Maximum width of test	3·00	3·15	3·50	4·10
Thickness of test	—	0·55	0·50	0·50

Description. — Test elongated, rhomboidal or semielliptical, much compressed, sides flattened, periphery rounded in the first portion, truncated in the remainder of test. Chambers numerous. Earliest coiled, but very quickly followed by typical chevron-shaped chambers, narrow, of rather uniform width. Proloculum small, slightly elevated. Sutures distinct, high, between the last chambers depressed. Wall smooth, polished, aperture radiate, terminal, often with a slight neck.

Variation. — Considerable; applies to general shape. Some specimens more slender, some more enlarged, nearly rhomboidal.

Remarks. — Rhomboidal specimens can easily be confused with *Palmula robusta* BROTZEN, described from Klagshamn's Paleocene.

Distribution. — Common in Upper Maastrichtian in Poland as well as in Danian. Rare in Montian, where probably is derived. Typical of Lower Danian in Denmark. This species occurs in Upper Cretaceous of Sweden, Germany, probably in America too.

Palmula robusta BROTZEN, 1948

(Plate V, fig. 1)

1948. *Palmula (Flabellina) robusta* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 45, pl. 8, fig. 4, 5, text-fig. 9.
1954. *Palmula robusta* BROTZEN; K. POŻARYSKA, O przewodnich otwornicach..., p. 257, text-fig. 11.
1956*a*. *Palmula robusta* BROTZEN; J. HOFKER, Les Foraminifères..., p. 198, fig. 75.
1957. *Palmula robusta* BROTZEN; F. BROTZEN & K. POŻARYSKA, The Paleocene in central Poland, p. 274.
1957. *Palmula robusta* BROTZEN; J. HOFKER, Foraminiferen..., p. 144, text-fig. 168-170.
1964. *Palmula robusta* BROTZEN; K. POŻARYSKA, On some Foraminifera..., p. 544, pl. 4, figs 1-27.

Material. — A hundred or so specimens, well preserved.
Dimensions of 3 specimens (in mm.):

	1	*2*	*3*
Length of test	1·77	2·65	4·55
Maximum width of test	1·30	1·95	3·20
Thickness of test	0·35	0·25	0·40

Description. — Test large, elongated, the greatest breadth near the middle. Sides very flattened, almost flat, periphery truncated or rounded. Chambers numerous, first 2-3 coiled, the next chevron-shaped, strongly overlapping the last ones. Sutures distinct, thick, high, not raised between last chambers. Aperture radiate, terminal on the top of the last formed chamber. Proloculum elevated, with 2 or 3 ribs on the surface. Wall smooth, polished.

Variation. — In general shape only.

Remarks. — This species is very similar to *Palmula elliptica* (NILSSON). But our test is not so slender, being broader, nearly rhomboidal, having a bigger proloculum with distinctly raised ribs. Does not differ from the holotype. Very similar species, present in Cretaceous of Paris Basin, described by D'ORBIGNY as *Flabellina pulchra* (1840, pl. 2, fig. 12-14). Its proloculum has 3 small ribs or tubercles, test rhomboidal and the proportion between coiled area and remainder of test is the same as in *Palmula robusta* BROTZEN. The periphery only is truncated, not rounded at all.

Distribution. — Not common in Maastrichtian and Danian. Common in Montian, especially at Boryszew boring. Cited from the Upper Maastrichtian of Belgium, the Netherlands and Germany, and from the lower part of Swedish Paleocene.

Genus **CITHARINA** D'ORBIGNY, 1839

Citharina plumoides (PLUMMER, 1926)

(Plate XI, fig. 10)

1926. *Vaginulina plumoides* PLUMMER; J. H. PLUMMER, Foraminifera of the Midway..., p. 113, pl. 6, fig. 6.
1960. *Citharina plumoides* (PLUMMER); R. K. OLSSON, Foraminifera..., p. 19.

Material. — Some damaged specimens.
Dimensions of 2 specimens (in mm.):

	1	*2*
Length of test	1·50	2·10
Maximum width of test	0·60	0·50
Thickness of test	0·10	0·15

Description. — Test large, wing-shaped, much compressed, spreading rapidly upward, periphery rounded or slightly truncated, initial end bluntly acute, chambers distinct, very low, numerous, up to 17 in number, very slightly if at all inflated, very oblique, increasing very gradually but regularly in breadth and height, sutures distinct, straight or slightly curved, very strongly oblique, slightly raised. Aperture not known. Wall smooth.

Remarks. — Our specimens are larger than the holotype described from North America. They are devoid of striae like those specimens described by PLUMMER (1926).

Distribution. — Very rare in Montian at Boryszew. Rare in the Paleocene of Europe as well as of North America. This characteristic species has been reported only from beds of Paleocene age.

Citharina sp.

(Plate XI, figs. 8, 9)

1957. *Citharina* cf. *strigillata* REUSS; K. POŻARYSKA, Lagenidae du Crétacé sup. de Pologne, p. 172, pl. 14, fig. 11.

Material. — Two specimens, well preserved.
Dimensions (in mm.):

	1	*2*
Length of test	0·65	1·44
Maximum width of test	0·10	0·20

Description. — Test slender, delicate, much compressed, somewhat fusiform in front view, tapering toward both ends, periphery truncated, chambers few, up to 4 in number, not inflated, elongated, increasing very gradually in size as added, sutures distinct, slightly curved, raised, broken by numerous short costae, parallel to the straight edge of the test. Proloculum strongly elongated, slightly inflated.

Remarks. — Our specimens have a very elongate proloculum, never previously described in any species of *Citharina*. On one specimen all striae are lacking.

Distribution. — Both specimens have been found in Danian at Góra Puławska.

Genus **FRONDICULARIA** DEFRANCE, 1826

Frondicularia biformis MARSSON, 1878

(Plate XI, fig. 1)

1878. *Frondicularia biformis* MARSSON; T. MARSSON, Die Foraminiferen..., p. 137, pl. 2, fig. 17*c-d*.
1925. *Frondicularia biformis* MARSSON; A. FRANKE, Foraminiferen..., p. 53, pl. 4, fig. 19*a-b*.
1946. *Frondicularia* sp. *A*; J. A. CUSHMAN & R. TODD, Foraminiferal fauna..., p. 2, pl. 9, fig. 24.
1951. *Frondicularia* sp. *A*; J. A. CUSHMAN, Paleocene Foraminifera..., p. 31, pl. 9, fig. 6.
1957. *Frondicularia biformis* MARSSON; K. POŻARYSKA, Lagenidae du Crétacé sup. de Pologne, p. 139, pl. 20, fig. 7, text-fig. 33*a-g*.
1960. *Frondicularia* sp.; R. K. OLSSON, Foraminifera..., p. 22, pl. 3, fig. 19.

Material. — Some dozens of specimens, well preserved.
Dimensions of 4 specimens (in mm.):

	1	*2*	*3*	*4*
Length of test	0·50	0·60	0·60	0·70
Width of test	0·30	0·30	0·36	0·30
Thickss of test	0·10	0·10	0·10	0·10

Description — Test shneort, strongly compressed, somewhat less than twice as long a broad, outline lobulate, periphery truncated, tapering in early portion, becoming nearly parallel in the adult. Chambers few, up to 5 in number, chevron-shaped, overlapping, sutures distinct, strongly oblique, limbate, raised. Aperture radiate on the top of last formed chamber. Proloculum very small, tapering rapidly. Wall smooth, slightly depressed along the axis of test, where sutures are not continuous.

Variation. — Considerable; it applies mainly to general shape either tapering or enlarging toward apertural end.

Remarks. — Our specimens do not differ from the holotype described from Upper Cretaceous of Germany. It is the only one species of *Frondicularia* crossing the boundary Cretaceous-Tertiary (POŻARYSKA, 1957, p. 11-12).

Distribution. — Common in Upper Cretaceous as well as in Lower Tertiary in almost all studied samples. Known from Cretaceous of Europe, common in Danian of Limburg. This species occurs also in Upper Cretaceous of North America (OLSSON, 1960, CUSHMAN, 1951).

Family POLYMORPHINIDAE D'ORBIGNY, 1846

Genus GUTTULINA D'ORBIGNY, 1839

Guttulina communis D'ORBIGNY, 1826

(Plate XII, figs. 1*a-b*)

1826. *Guttulina communis* D'ORBIGNY; A. D'ORBIGNY, Ann. Sci. Nat., No. 15, p. 266, pl. 12, fig. 1-4.
1948. *Guttulina communis* D'ORBIGNY; F. BROTZEN, The Swedish Paleocene..., p. 49, text-pl. 10, fig. 6.

Material. — Some hundreds of specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·75
Width of test	0·56

Description. — Test subovate, somewhat compressed, bluntly rounded at the base, slightly tapering at the apertural top. Nearly circular in the transverse section. Chambers few, only 3-4 in number, the last few strongly overlapping the earliest ones. Sutures oblique, slightly curved, gently depressed. Wall smooth. Aperture radiate.

Remarks. — Chambers arranged like in *Guttulina problema* D'ORB., very similar to *G. problema* D'ORB. The difference between the latter and *G. communis* D'ORB. is described by BROTZEN (1948). CUSHMAN and OZAWA (1930) do not distinguish *G. communis* D'ORB. and *G. problema* D'ORB. in their monograph on Polymorphinidae. The first is put into the infraspecific variety of the latter.

Distribution. — Very common in Danian as well as in Montian in all studied samples. Present as early as in Maastrichtian. Common in Montian of Paris Basin, in Danian and Lower Paleocene (Selandian) of Sweden and Denmark. It is quite possible that this species exists everywhere in Upper Cretaceous and Lower Tertiary deposits, but is only described under several specific names, as e.g. *Guttulina irregularis*, *G. problema* etc. Present in Crimea too.

Guttulina hantkeni CUSHMAN & OZAWA, 1930

(Plate XII, figs. 4*a-b*)

1930. *Guttulina hantkeni* CUSHMAN & OZAWA; J. A. CUSHMAN & Y. OZAWA, A Monograph..., p. 33, pl. 5, fig. 4-6.
1948. *Guttulina hantkeni* CUSHMAN & OZAWA; F. BROTZEN, The Swedish Paleocene..., p. 49, text-pl. 10, fig. 9.
1951. *Guttulina hantkeni* CUSHMAN & OZAWA; J. A. CUSHMAN, Paleocene Foraminifera..., p. 32, pl. 9, fig. 20, 21.
1959. *Guttulina hantkeni* CUSHMAN & OZAWA; J. HOFKER, Les Foraminifères..., p. 7.
1960. *Guttulina hantkeni* CUSHMAN & OZAWA; R. K. OLSSON, Foraminifera..., p. 25, pl. 3, fig. 23.

Material. — About 30 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	1·05
Maximum width of test	0·60

Description. — Test oval, botryoidal, variable, undulated outline, rounded at the base, acute at the apertural end, widest about the middle or a little higher. Chambers ovate, somewhat elongated, slightly overlapping each other. Test composed of a normal quinqueloculine series, arranged in an anti-clockwise spiral. Chambers more or less inflated, successively removed,

further from the base. The last one strongly swollen, protruding. Wall smooth. Sutures distinct, deeply depressed. Aperture radiate.

Variation. — This species shows considerable variation, mainly in general shape and outline, which can be more lobulate or less lobulate.

Remarks. — Our specimens compare well with the holotype described from Eocene in Hungary by CUSHMAN and OZAWA.

Distribution. — Not common in Danian and in Montian in all studied localities in Poland. Well known throughout the Tertiary of North America and Europe. According to HOFKER (1959), present in Maastrichtian's Tuffeau in Limburg, as well as in Saint-Symphorien's Tuffeau in Basin of Mons.

Guttulina muensteri (REUSS, 1856)

(Plate XIII, figs. 2*a-b*)

1856. *Polymorphina münsteri* REUSS; A. E. REUSS, Beiträge zur Charakteristik der Tertiärschichten, p. 249, pl. 8, fig. 80*a-c*.

Material. — About 50 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·80
Maximum width of test	0·54

Description. — Test oval, in transverse section elliptical, acute on both sides, the initial end slightly rounded, widest about the middle. Chambers few, embracing each other slightly, gently inflated; sutures distinct, straight or slightly curved, flush with surface. Wall smooth, aperture large, radiate.

Variation. — Insignificant, mainly in general shape, non lobulate outline.

Remarks. — This species is similar to the *Guttulina roemeri* (REUSS), but is not so swollen and not so asymmetrical in general outline. Arrangement of chambers the same. Chambers not overlapping. Our specimens do not differ from the holotype described by REUSS from the Oligocene.

Distribution. — Not common in Danian and in Montian in all studied samples.

Guttulina problema D'ORBIGNY, 1826

(Plate XII, figs. 2*a-b*)

1826. *Guttulina problema* D'ORBIGNY; A. D'ORBIGNY, Ann. Sci. Nat., No. 15, p. 266, pl. 26, fig. 14.
1926. *Polymorphina communis* D'ORBIGNY; H. J. PLUMMER, Foraminifera of the Midway..., p. 123, pl. 6, fig. 12*a-b*.
1930. *Guttulina problema* D'ORBIGNY; J. A. CUSHMAN & Y. OZAWA, A Monograph..., p. 19, pl. 2, fig. 1-6.
1946. *Guttulina problema* D'ORBIGNY; R. C. VAN BELLEN, Foraminifera..., p. 35, pl. 2, fig. 28.
1948. *Guttulina problema* D'ORBIGNY; F. BROTZEN, The Swedish Paleocene..., p. 49, text-pl. 10, fig. 7.
1951. *Guttulina problema* D'ORBIGNY; J. A. CUSHMAN, Paleocene Foraminifera..., p. 32, pl. 9, fig. 15-18.
1958. *Guttulina problema* D'ORBIGNY; J. HAYNES, Certain smaller..., p. 5, pl. 3, fig. 5*a-c*.

Material. — About 200 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·54
Maximum width of test	0·36

Description. — Test broadly fusiform, globose, ovate, outline lobulate, acute at the apertural end, more or less rounded at the base. Greatest width towards the middle, trigonal in section. Chambers elongated, up to about 7 in number, strongly inflated, successively removed from the base, but not quite regularly. Test composed of a normal quinqueloculine series, arranged in an anti-clockwise spiral. Sutures distinct, depressed. Wall smooth. Aperture radiate on the top.

Variation. — Specimens referred to this species show considerable variation.

Remarks. — Very similar to *Guttulina communis* D'ORBIGNY. Some authors do not distinguish *G. problema* D'ORB. from *G. communis* D'ORB. However BROTZEN (1948) stated in samples from Ystad (Swedish Paleocene) that the length/breadth proportion is 0.87 for *G. communis*, while only 0.55-0.60 for *G. problema*. Therefore this author has distinguished between these two species.

Distribution. — Very common in Danian as well as in Montian in all studied outcrops and borings. Well known throughout the Tertiary of North America and Europe.

Guttulina roemeri (REUSS, 1856)

(Plate XIII, figs. 7*a-b*)

1856. *Globulina römeri* REUSS; A. E. REUSS, Beiträge zur Charakteristik der Tertiärschichten, p. 245, pl. 6, fig. 63*a-c*.
1930. *Guttulina roemeri* (REUSS); J. A. CUSHMAN & Y. OZAWA, A Monograph..., p. 41, pl. 9, fig. 3*a-c*.
1948. *Guttulina roemeri* REUSS; F. BROTZEN, The Swedish Paleocene..., p. 49, text-pl. 10, fig. 12.

Material. — About 50 specimen, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·90
Maximum width of test	0·65

Description. — Test oval, swollen, outline asymmetrical, not lobulate, broadly rounded at initial end, bluntly acute at the apertural end, circular in transverse section, the greatest breadth above middle. Chambers inflated, oval, embracing, arranged in a nearly triserial series. Sutures distinct, straight or gently curved, flush with surface or very slightly depressed. Wall smooth, aperture radiate, often fistulose.

Variation. — Insignificant.

Remarks. — Our specimens are much larger than the holotype described by REUSS from Oligocene.

Distribution. — Not common in Danian and Montian at Bochotnica, Boryszew and Góra Puławska. Present in Paleocene of Sweden, Denmark and probably Paris Basin (P. MARIE, oral information).

Genus **GLOBULINA** D'ORBIGNY, 1839

Globulina arenacea BROTZEN, 1948

(Plate XXII, fig. 5)

1948. *Globulina arenacea* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 48, text-pl. 10, fig. 3*a-d*.

Material. — About 30 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·32
Maximum width of test	0·30

Description. — Test spherical or very slightly elongated; general shape of *Globulina gibba* D'ORB. circular or oval in section, rounded on the initial and apertural end. Chambers few, generally three, sutures flush with surface, often indistinct, wall covered with fine grains of sand of uniform size. Aperture radiate.

Variation. — Variation and test structure described in detail by BROTZEN (1948). Remarkable, highly distinctive species.

Remarks. — Our specimens do not differ from those described by BROTZEN (1948). Similar, at first glance, to subspecies of *Globulina gibba* described by D'ORBIGNY (1846), whose walls are covered with spines, tubercles or punctations, built not by quartz grains.

Distribution. — Rare in Danian and Montian at Góra Puławska, Pamiętowo, Boryszew, and Sochaczew; known from Lower Paleocene (Selandian) of Sweden.

Globulina gibba D'ORBIGNY, 1826

(Plate XIII, fig. 3)

1826. *Globulina gibba* D'ORBIGNY; A. D'ORBIGNY, Ann. Sci. Nat., No. 15, p. 266, fig. 63.
1926. *Polymorpha gibba* D'ORBIGNY; H. J. PLUMMER, Foraminifera of the Midway..., p. 122, pl. 6, fig. 8.
1930. *Globulina gibba* D'ORBIGNY; J. A. CUSHMAN & Y. OZAWA, A Monograph..., p. 60, pl. 16, fig. 1-4 (earliest synonymy included).
1946. *Globulina gibba* D'ORBIGNY; R. C. VAN BELLEN, Foraminifera..., p. 37, pl. 3, fig. 4.
1948. *Globulina gibba* D'ORBIGNY; F. BROTZEN, The Swedish Paleocene..., p. 46, text-pl. 10, fig. 1, 2.
1951. *Globulina gibba* D'ORBIGNY; J. A. CUSHMAN, Paleocene Foraminifera..., p. 33, pl. 9, fig. 26-28.
1957. *Globulina gibba* D'ORBIGNY; F. BROTZEN & K. POŻARYSKA, The Paleocene in central Poland, p. 274.
1958. *Globulina gibba* D'ORBIGNY; J. HAYNES, Certain smaller..., p. 8, pl. 3, fig. 10.
1960. *Globulina gibba* D'ORBIGNY; R. K. OLSSON, Foraminifera..., p. 25, pl. 3, fig. 25.

Material. — About 100 specimens, well preserved.

Dimensions of an average specimen (in mm.):

Length of test	0·50
Maximum width of test	0·45

Description. — Test globular or subglobular, in section circular or somewhat ovate. Chambers few, embracing, inflated, rounded, arranged in a nearly triserial series. Chambers do not always equally overlap and are not regularly arranged. Sutures not very distinct. Wall smooth, sometimes with fistulose tube, especially at apertural end. Aperture radiate.

Variation. — To a considerable degree.

Remarks. — Fistulose forms occur, but are rather rare. D'ORBIGNY's original specimen is lost. Typical *G. gibba* begins with the Tertiary. According to CUSHMAN's and OZAWA's detailed study (1930), there are no Mesozoic *G. gibba*.

Distribution. — Common in Danian as well as in Montian in all studied outcrops and borings. Known from almost all localities with Danian, Paleocene and younger sediments.

Genus **PYRULINA** D'ORBIGNY, 1839

Pyrulina fusiformis (ROEMER, 1838)

(Plate XIII, figs. 4*a-b*)

1838. *Polymorphina fusiformis* ROEMER; F. A. ROEMER, Die Cephalopoden..., p. 386, pl. 3, fig. 37*a-b*.
1930. *Pyrulina fusiformis* (ROEMER); J. A. CUSHMAN & Y. OZAWA, A Monograph..., p. 55, pl. 13, fig. 3-8 (earlier synonymy included).

1946. *Pyrulina fusiformis* (ROEMER); R. C. VAN BELLEN, Foraminifera..., p. 40, pl. 3, fig. 11.
1948. *Pyrulina fusiformis* ROEMER; F. BROTZEN, The Swedish Paleocene..., p. 48, text-pl. 10, fig. 4.
1957. *Pyrulina fusiformis* ROEMER; F. BROTZEN & K. POŻARYSKA, The Paleocene in central Poland, p. 274.
1958. *Pyrulina fusiformis* (ROEMER); J. HAYNES, Certain smaller..., p. 7, pl. 3, fig. 8-8i.

Material. — Some specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	1·95
Width of test	0·60

Description. — Test elongated, with rounded base and tapering apex, oval or circular in section. Chambers few, up to 8 in number, biserial throughout, of rather uniform shape, slowly increasing in size as added. Sutures distinct, flush with surface, arranged at about 45° to the horizontal. Wall smooth. Aperture radiate, large on the top.

Variation. — Figured in HAYNES' paper (1958).

Remarks. — Our specimens are the same as some of those described by HAYNES (1958, fig. 8f on pl. 3).

Distribution. — Rare in Montian at Bochotnica, Boryszew, Góra Puławska and Nasiłów. Known from British and Swedish Paleocene, as well as from south regions of Russian platform. Common in Upper Tertiary sediments.

Genus **PSEUDOPOLYMORPHINA** CUSHMAN & OZAWA, 1928

Pseudopolymorphina frondea (CUSHMAN, 1922)

(Plate XII, figs. 5, 6)

1922. *Bolivina frondea* CUSHMAN; J. A. CUSHMAN, The Foraminifera..., p. 126, pl. 29, fig. 3.
1951. *Polymorphina frondea* (CUSHMAN); J. A. CUSHMAN, Paleocene Foraminifera..., p. 35, pl. 10, fig. 13.
1960. *Polymorphina frondea* (CUSHMAN); R. K. OLSSON, Foraminifera..., p. 26, pl. 3, fig. 28.

Material. — About 30 specimens, well preserved.
Dimensions of two specimens (in mm.):

	1	*2*
Length of test	0·82	0·57
Maximum width of test	0·47	0·36

Description. — Test much compressed, sides flat, rhomboidal, broad, periphery truncated or slightly rounded. Early portion of test gradually tapering. Chambers low, of uniform shape as added, alternating throughout. Sutures distinct, flush with surface, oblique, slightly curved. Wall smooth. Aperture radiate on the top of the last formed chamber.

Variation. — Small; all specimens are of rather uniform size and shape.

Remarks. — In comparison with the holotype from Lower Oligocene our specimens have not such a rounded periphery and are smaller. Rather peculiar species, not resembling other species belonging to this family.

Distribution. — Not common, neither in Danian nor in Montian, at Bochotnica, Boryszew, Góra Puławska, Pamiętowo and Sochaczew. This species occurs in a few specimens in America beginning with the Paleocene up to Oligocene.

Pseudopolymorphina geijeri angusta BROTZEN, 1948

(Plate XII, figs. 8*a-b*)

1948. *Pseudopolymorphina geijeri angusta* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 52, text-pl. 10. fig. 15, text-fig. 12.
1963. *Dyofrondicularia geijeri* (BROTZEN); O. K. KAPTARENKO-ČERNOUSOVA *et al.*, Atlas..., p. 134, pl. 29, fig. 5, 6.

Material. — About 20 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	1·8
Maximum width of test	1·1

Description. — Test big, elongated, compressed, oval, greatest breadth above the middle. Periphery broadly rounded. Chambers low, elongated, strongly curved, overlapping, slightly inflated, alternating throughout. Sutures distinct, gently depressed. Wall has distinct, longitudinal, parallel costae. Aperture radiate.

Variation. — Described in detail by BROTZEN (1948).

Remarks. — Our specimens have more elongated, ellipsoidal proloculum, not so short as described by BROTZEN (1948).

Distribution. — Few specimens in Danian at Góra Puławska and Pamiętowo, as well as in Montian at Bochotnica, Boryszew and Sochaczew. Present in Bunde Formation (the Netherlands), where identified by P. MARIE (oral information), and in Paleocene of Donetz Basin.

Pseudopolymorphina paleocenica BROTZEN, 1948

(Plate XIII, fig. 6)

1948. *Pseudopolymorphina paleocenica* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 50, text. pl. 10, fig. 13, text-pl. 11, fig. 1-22.
1957. *Pseudopolymorphina paleocenica* BROTZEN; F. BROTZEN & K. POŻARYSKA, The Paleocene in central Poland, p. 275.
1963. *Pseudopolymorphina paleocenica* BROTZEN; J. HOFKER, Foraminifera from the Cretaceous..., LXV, p. 56, fig. 5*a-c*.

Material. — About 50 specimens, well preserved.
Dimensions of two specimens (in mm.):

	1 typical	*2* conformis
Length of test	2·25	2·70
Maximum width of test	0·90	1·40

Description. — Test large, elongated, compressed, acute in both ends, periphery broadly rounded, nearly parallel, lobate. Chambers numerous, in the early portion slightly twisted, in the remainder of test arranged biserially. Sutures transparent, distinct, very slightly depressed, nearly flush with surface. Convex towards the apertural top, never straight. Wall smooth. Aperture radiate, big on the top of last formed chamber.

Variation. — Discussed in detail by BROTZEN (1948).

Remarks. — Our specimens do not differ from the Swedish ones.

Distribution. — Not very common in Danian at Sochaczew, more common in Montian at Bochotnica, Boryszew, Góra Puławska, Pamiętowo and Sochaczew. This species occurs in Lower Paleocene (Selandian) of Sweden, Denmark, the Netherlands and in Crimea.

Genus **SIGMOMORPHINA** CUSHMAN & OZAWA, 1928

Sigmomorphina brotzeni HOFKER, 1957

(Plate XII, figs. 3*a-b*)

pars 1948. *Sigmomorphina soluta* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 53.
1957. *Sigmomorphina brotzeni* HOFKER; J. HOFKER, Foraminifera from the Cretaceous..., XXIII, p. 18, text-fig. 18-26.

Material. — About 60 specimens, some of them damaged.
Dimensions of an average specimen (in mm.):

Length of test	0·82
Maximum width of test	0·30

Description. — Test long, strongly compressed, slender, elongated, fusiform, composed of comparatively few chambers, 3-4 in number, strongly elongated, sigmoidal, three or four times as long as wide. Initial end with a short, stout spine, the last being voluminous. Sutures distinct, depressed, strongly oblique. Wall smooth. Aperture radiate, terminal.

Remarks. — According to HOFKER (1957), this species developed from *Sigmomorphina soluta* BROTZEN (1948), becoming more and more slender. Our specimens are the same as described by HOFKER from Limburg (1957).

Distribution. — Rare in Danian at Góra Puławska, more common in Montian at Góra Puławska, Sochaczew and Pamiętowo.

Sigmomorphina pseudoregularis CUSHMAN & THOMAS, 1930

(Plate XII, fig. 9)

1930. *Sigmomorphina pseudoregularis* CUSHMAN & THOMAS; J. A. CUSHMAN & Y. OZAWA, A Monograph..., p. 125, pl. 32, fig. 8.
1948. *Sigmomorphina pseudoregularis* CUSHMAN & THOMAS; F. BROTZEN, The Swedish Paleocene..., p. 54, text-pl. 10, fig. 17.

Material. — 8 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	1·40
Maximum width of test	0·90

Description. — Test large, thick, length about twice width, compressed, periphery broadly rounded, median longitudinal ridge on both sides, chambers arranged in bilateral symmetry, left set has numerous chambers — up to 6, parallel to each other, oblique to margin, bending in a gentle curve backwards, while right set has only few chambers, bending directly downwards. Both ends acute. Sutures distinct, slightly depressed. Aperture radiate. Wall smooth.

Remarks. — Our specimens are similar to those figured by CUSHMAN and OZAWA (1930), as well as to those figured by BROTZEN (1948). Median longitudinal ridge is very weakly developed in Polish specimens or is even entirely lacking, while in American specimens from Eocene a long, strong longitudinal ridge is very distinct and sutures slope backwards while crossing the ridge. In Polish Montian they represent probably the beginning of the development, while in American Eocene they are already fully developed.

Distribution. — Rare in Montian at Góra Puławska, more common in Montian at Boryszew and Sochaczew. Common in Selandian of Sweden and in Eocene of North America.

Sigmomorphina soluta BROTZEN, 1948

(Plate XII, figs. 7*a-b*)

1948. *Sigmomorphina soluta* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 53, pl. 8, fig. 6-10.
1956*a*. *Sigmomorphina soluta* BROTZEN; J. HOFKER, Les Foraminifères..., p. 196, fig. 62.
1957. *Sigmomorphina soluta* BROTZEN; F. BROTZEN & K. POŻARYSKA, The Paleocene in central Poland, p. 275.
1964. *Sigmomorphina soluta* BROTZEN; K. POŻARYSKA, On some Foraminifera..., p. 546, pl. 1, fig. 13-19.

Material. — About 40 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·70
Maximum width of test	0·37

Description. — Test large, compressed, elongated or rhomboidal, periphery broadly rounded, greatest breadth above middle, outline variable, sometimes lobated. Chambers sigmoidal, few in number, later biserial, slightly inflated. Sutures distinct, somewhat depressed. Wall smooth. Aperture radiate on the acute apertural end of the last formed chamber.

Variation. — Described in detail by BROTZEN (1948).

Remarks. — Our specimens having few chambers could represent young stages of *Sigmomorphina pseudoregularis* CUSHMAN & THOMAS. Beginning of test does not form a stout spine, like in the holotype described from the Selandian by BROTZEN (1948). HOFKER mentioned (1956) the first appearance of the primitive representatives of this species as early as from the Upper Maastrichtian of Belgium and the Netherlands.

Distribution. — Common in Danian as well as in Montian at Bochotnica, Boryszew, Góra Puławska, Nasiłów, Pamiętowo, Sochaczew and Żyrzyn. Present in Danian at Limburg, Tuffeau de Ciply (Mons) and in Bunde Formation, as well as in the Upper Maastrichtian at Limburg.

Genus **BULLOPORA** QUENSTEDT, 1856

Bullopora sp.

(Plate XIV, fig. 9)

Material. — One specimen, damaged.
Dimensions (in mm.):

Length of test	1·20
Maximum width of test	0·50

Description. — Test attached, consisting of some globular, oval, fusiform chambers, arranged in a single series joined together. Wall covered by minute spines. Opening round, projecting on the neck, asymmetrically lying just beneath the top of the last formed chamber.

Remarks. — Similar to *Bullopora tuberculata* (SOLLAS).

Distribution. — Our specimen was found in Upper Maastrichtian at Czerniejów.

Genus **GLANDULINA** D'ORBIGNY, 1839

Glandulina laevigata (D'ORBIGNY, 1826)

(Piate XXII, fig. 7)

1826. *Nodosaria (Glandulina) laevigata* D'ORBIGNY; A. D'ORBIGNY, Tableau méthodique..., p. 252, pl. 118, fig. E (*fide* ELLIS & MESSINA, Catal. of Foraminifera).
1846. *Glandulina laevigata* D'ORBIGNY; A. D'ORBIGNY, Foraminifères fossiles .., pl. 1, fig. 4, 5.
1959. *Glandulina laevigata* D'ORBIGNY; G. DIECI, I foraminiferi..., p. 52, pl. 4, fig. 21.

Material. — Some specimens, usually damaged at apertural end.
Dimensions of an average specimen (in mm.):

Length of test	0·67
Maximum width of test	0·35

Description. — Test fusiform, strongly tapering towards both ends, outline non lobulate, round in transverse section, chambers few, 3-4 in number, crowded towards basal end. Chambers arranged in one row, except the early portion of test, the last chamber occupy 3/4 of whole test. Sutures not very distinct, flush with surface. Wall thin, smooth. Aperture round, small on the top of the last formed chamber.

Variation. — Very distinctive species.

Remarks. — Our specimens do not differ from the holotype described from the Tertiary of Vienna Basin.

Distribution. — Very rare in Danian and Montian in almost all studied quarries and borings, except Pamiętowo. Common in younger Tertiary strata.

Genus **RAMULINA** JONES, 1875

Ramulina sp.

(Plate XIV, figs. 5-8)

Material. — 3 specimens, well preserved.
Dimensions of 2 specimens (in mm.):

	1	*2*
Length of test	1·60	1·90
Maximum width of test	0·80	0·20

Description. — 1st specimen: Test consisting of a central, more or less globular portion, from which extend radiate, comparatively large, stout, tubular, tapering projections. Wall of central portion as well as of arms covered by small spines.

2nd specimen: Test consisting of irregularly elongated tubular arms, somewhat tapering towards both ends which have rounded openings. Wall thin, finely hispid.

Remarks. — These few specimens belonging to *Ramulina* are close to those known from Upper Cretaceous, thus they are probably derived. Similar species are described by BRADY (1884) from recent seas. The early stages of these peculiar forms are unknown up to now, therefore it is very difficult to define their systematic position.

Distribution. — Common in Cretaceous. In lowermost Tertiary probably derived.

Family MILIOLIDAE D'ORBIGNY, 1839

Genus **QUINQUELOCULINA** D'ORBIGNY, 1826

Quinqueloculina sp.

(Plate XIV, figs. 4*a-b*)

Material. — A few specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·49
Maximum width of test	0·34

Description. — Test small, compressed, broadly elliptical, periphery broadly rounded, chambers inflated, a half coil in length, 4 in number on one side, 3 — on the other, sutures distinct, depressed, aperture rounded with a simple tooth, at the end of the last formed chamber. Wall smooth.

Distribution. — This species occurs in Montian at Sochaczew.

Family HETEROHELICIDAE CUSHMAN, 1927

Genus **CHILOGUEMBELINA** LOEBLICH & TAPPAN, 1956

Chiloguembelina wilcoxensis (CUSHMAN & PONTON, 1932)

(Plate XXII, fig. 6)

1932. *Gümbelina wilcoxensis* CUSHMAN & PONTON; J. A. CUSHMAN & G. M. PONTON, An Eocene..., p. 66, pl. 8, fig. 16-17.

1941. *Gümbelina wilcoxensis* CUSHMAN & PONTON; L. D. TOULMIN, Eocene smaller Foraminifera..., p. 597, pl. 80, fig. 24.

1957. *Chiloguembelina wilcoxensis* (CUSHMAN & PONTON); J. P. BECKMAN, *Chiloguembelina*..., p. 92, pl. 21, fig. 10-13.

Material. — Some dozen specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·36
Maximum width of test	0·26
Thickness of test	0·20

Description. — Test minute, compressed, rapidly tapering, acutely angular at base, broadly rounded at apertural end, with the greatest breadth formed by last pair of chambers, outline lobulate, chambers distinct, strongly inflated, globular, arranged in two rows, increasing rapidly in size as added, 4-6 chambers in one row. Sutures distinctly depressed. Wall thin, papillate, aperture a semicircular opening at the base of the last formed chamber.

Remarks. — This species is somewhat similar to some Cretaceous species of *Heterohelix*. Our specimens are very similar to the holotype and specimens described from Trinidad and Alabama.

Distribution. — Common, mainly in Montian, at Bochotnica, Góra Puławska, Pamiętowo and Żyrzyn. Rare in Danian at Góra Puławska. Known from Upper Paleocene and Lower Eocene in North America.

Family NONIONIDAE SCHULTZE, 1854

Genus **PULLENIA** PARKER & JONES, 1862

Pullenia americana paleocenica BROTZEN, 1948, emend. POŻARYSKA, 1965

(Plate XXI, figs. 4*a-b*)

1948. *Pullenia* aff. *americana* CUSHMAN var. *paleocenica* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 68, pl. 8, fig. 3 (given in heading p. 68, in plate explanation and throughout the text as *Pullenia* aff. *americana* CUSHMAN) (earlier synonymy included).

Material. — About 150 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·33
Shortest diameter of test.	0·29
Maximum thickness of test	0·18

Description. — Test compressed, round, thick, planispiral, the same on both sides, outline circular, not lobulate or only very slightly, periphery broadly rounded, sutures distinct, flush with surface or slightly depressed. Chambers of uniform shape as added, gradually increasing in size, somewhat more than 5 chambers in last whorl. Apertural face large, crescent, strongly overlapping the preceding chamber. Wall smooth, finely poreous, glistening.

Variation. — Insignificant. This species is highly distinctive.

Remarks. — Our specimens do not differ from Swedish ones. In comparison with the specimen presented by BROTZEN (1948) our specimens are less lobulate in general outline and their sutures are almost flush with surface, not depressed.

Distribution. — Very common in uppermost Maastrichtian, Danian and Montian in all studied localities. Known from Swedish and Danish Upper Danian and Lower Paleocene (Selandian).

Genus **NONION** MONTFORT, 1808

Nonion graniferum (TERQUEM, 1882)

(Plate XXI, figs. 5*a-b*)

1882. *Nonionina granifera* TERQUEM; O. TERQUEM, Les Foraminifères..., p. 42, pl. 2, fig. 8*a-b*, 9*a-b*.
1939. *Nonion graniferum* (TERQUEM); J. A. CUSHMAN, A Monograph..., p. 4, pl. 1, fig. 9-11.
1948. *Nonion* cf. *graniferum* (TERQUEM); F. BROTZEN, The Swedish Paleocene..., p. 69, pl. 8, fig. 1.
1950. *Nonion graniferum* (TERQUEM); Y. LE CALVEZ, Révision..., p. 53, pl. 4, fig. 58, 59.
1952. *Nonion graniferus* (TERQUEM); N. A. VOLOŠINOVA & L. G. DAJN, Nonionidy..., p. 21, pl. 1, fig. 9*a-b*, non fig. 12*a-b*.

Material. — Over 60 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·32
Shortest diameter of test	0·27
Maximum thickness of test	0·15

Description. — Test rounded, circular, compressed, umbilical region sometimes larger, sometimes less, peripheral margin broadly rounded, lobulate, chambers distinct, slightly inflated, 8 in number in last whorl, sutures distinct, depressed, gently curved. Umbilical region covered with finely grained granulation, filling a part of sutures. Aperture: an elongated, narrow slit at the base of last formed chamber. Wall smooth, finely perforated.

Variation. — Insignificant, applies mainly to dimensions of granulated umbilical region.

Remarks. — Our specimens are quite the same as the holotype described by TERQUEM (fig. 8 a-b), however they differ from fig. 9 a-b, never having such spines on the inner side of chambers.

Distribution. — Common in Danian and Montian at Sochaczew and Pamiętowo. Known from the Paleogene beds in America as well as in Europe and Asia.

Genus **NONIONELLA** CUSHMAN, 1926

Nonionella ovata BROTZEN, 1948

(Plate XXI, figs. 1*a-c*)

pars 1926. *Nonionina turgida* PLUMMER (not WILLIAMSON); H. J. PLUMMER, Foraminifera of the Midway..., p. 159, pl. 12, fig. 7.
1948. *Nonionella ovata* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 68, pl. 10, fig. 13, 14.
1951. *Nonionella* sp.; J. A. CUSHMAN, Paleocene Foraminifera..., p. 37, pl. 11, fig. 5, 6.
1952. *Nonionella ovata* BROTZEN; C. W. DROOGER, Foraminifera..., p. 94.

Material. — Over 100 specimens, most of them damaged.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·29
Shortest diameter of test	0·19
Maximum thickness of test	0·10

Description. — Test small, delicate, ovate in outline, non-lobulate, triangular in section, not equally biconvex, about half as broad as long, peripheral margin acute in early portion of test, rounded in the remainder of test. Chambers few, 5-6 in number, on the dorsal side test closely coiled, on ventral side a very small umbilicus. The last chamber larger, extending sharply downwards on the ventral side. Sutures indistinct, flush with surface. Wall smooth, transparent, very thin. Aperture, a very narrow slit at the base of last formed chamber.

Variation. — Insignificant. Species very distinctive.

Remarks. — Our specimens do not differ from the holotype described from Paleocene of Sweden. Similar to species *Nonionella africana* LE ROY described from Egypt, Magfi section (LE ROY, 1953, pl. 10, fig. 9-11). This latter species only differs from *Nonionella ovata* BROTZEN by having about twice as many very low chambers in the last whorl.

Distribution. — Common in Danian and Montian at Bochotnica and Góra Puławska, rare in Pamiętowo and Żyrzyn. This species occurs rarely in the Paleocene at Klagshamn (Sweden) and in Denmark. Known as rare in Paleocene of Texas and in Midway Formation.

Nonionella troostae troostae HOFKER, 1962

(Plate XXI, fig. 7*a-b*)

1962. *Nonionella troostae troostae* HOFKER; J. HOFKER, Foraminifera from the Cretaceous..., LIX, p. 35, pl. 59, text-fig. 4, 5.

Material. — 50 specimens, about half of them with last chambers damaged. Dimensions of an average specimen (in mm.):

Longest diameter of test	0·70
Shortest diameter of test	0·40
Thickness of test	0·27

Description. — Test planispiral, elongated, somewhat asymmetrically coiled, ovate in outline, non-lobulate, twice as long as broad, compressed, peripheral margin rounded. Chambers distinct, low, elongated, rapidly increasing in size as added, overlapping, the latest chambers very strongly elongated, 11 in number, sutures distinct, gently curved, flush with surface, not meeting in the middle. Central part covered by conspicuous granulations which follow sutures as well as spaces between sutures for a short distance. Apertural face very elongated, with nearly parallel sides. Aperture: a narrow marginal slit at the base of the last formed chamber. Wall thin, delicate, finely poreous.

Variation. — Insignificant, mainly in ratio length/width. Described in detail by HOFKER (1962).

Remarks. — Our specimens are very close to the holotype described from the Upper Maastrichtian (*Mb*) in the Netherlands. Ours however have some granulation not only in the centre of test, but also some short ribs on the spaces between sutures just near the center. This species has some similarity to *Nonionella cretacea* CUSHMAN. HOFKER studied the similarities and determined the line of development leading from Upper Cretaceous *Nonionella troostae ornamentata*, *N. troostae troostae*, through *N. troostae nodosa* and *N. cretacea* REUSS (not CUSHMAN), right up to *N. soldadoensis* — present in Montian and Thanetian.

Distribution. — In uppermost Maastrichtian, Danian and Montian in all studied samples, except those from the Żyrzyn boring. Recorded by HOFKER (1962) from Upper Maastrichtian, Danian and Montian in the Netherlands and Belgium, where it is more rare.

Family CYMBALOPORIDAE CUSHMAN, 1927

Genus **CYMBALOPORA** HAGENOW, 1851

Cymbalopora sp.

(Plate XIV, figs. 3*a-c*)

1948. *Cymbalopora* sp.: F. BROTZEN, The Swedish Paleocene..., p. 91, pl. 15, fig. 1*a-b*.

Material. — 14 specimens, some of them damaged. Dimensions of an average specimen (in mm.):

Longest diameter of test	1·60
Shortest diameter of test	1·45
Height of test	0·70

Description. — Test large, plano-convex, outline irregularly circular, peripheral margin angulate, sharply keeled, ventral side concave, dorsal side strongly convex. Over 3 whorls on dorsal side which is rough, coarsely perforated. Chambers not visible. On ventral side about 10 irregular depressions or tubes running from the periphery into the umbilicus, which is rather large, deep, elongated, joined with a peripheral depression. Keel large, thin, transparent, always more or less damaged.

Remarks. — These specimens resemble *Cymbalopora radiata* v. HAGENOW from the Cretaceous. Most of specimens are damaged. Probably derived.

Distribution. — Rare in Upper Maastrichtian at Pamiętowo and Sochaczew; rare in Montian at Góra Puławska, Pamiętowo and Sochaczew.

Family BULIMINIDAE JONES, 1876

Genus **BULIMINELLA** CUSHMAN, 1911

Buliminella parvula BROTZEN, 1948

(Plate XV, fig. 3)

1948. *Buliminella parvula* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 57, pl. 10, fig. 3, 4.
?1956*a*. *Praebulimina parvula* (BROTZEN); J. HOFKER, Les Foraminifères..., p. 196, fig. 66.
1957. *Buliminella parvula* BROTZEN; F. BROTZEN & K. POŻARYSKA, The Paleocene in central Poland, p. 274.
?1960. *Praebulimina parvula* (BROTZEN); J. HOFKER, Foraminifera from the Cretaceous..., XLVII, p. 15, pl. 47, text-fig. 1*a-c*.

Material. — Some specimens, well preserved.
Dimensions of 2 average specimens (in mm.):

	1	*2*
Length of test	0·36	0·45
Maximum width of test	0·30	0·38

Description. — Test very small, about as long as broad, tapering rapidly, chambers inflated, arranged in three or four whorls, four in number in each whorl. The last whorl increasing rapidly in size, forming 4/5 of the test. Sutures distinct, depressed. Wall smooth. Aperture loop-shaped, at the base of the last formed chamber.

Variation. — This species varies in the proportion of length/breadth.

Remarks. — Our specimens have a shorter earlier portion of test in comparison with the holotype. HOFKER (1956) mentioned the appearance of *Praebulimina parvula* (BROTZEN) as early as in the Upper Maastrichtian of Limburg, where this species could represent the most primitive stages of its development. Specimens from Danian stage not known, therefore it is rather difficult to identify Paleocene and Maastrichtian forms.

Distribution. — Very rare in the Montian at Sochaczew and Boryszew. Known from Sweden and the Netherlands.

Genus **LOXOSTOMUM** EHRENBERG, 1854, emend. HOWE, 1930

Loxostomum applinae (PLUMMER, 1926)

(Plate XV, fig. 6*a-b*)

1926. *Bolivina applini* PLUMMER; H. J. PLUMMER, Foraminifera of the Midway..., p. 69, pl. 4, fig. 1.
1930. *Loxostomum applinae* (PLUMMER); W. L. F. NUTTALL, Eocene Foraminifera..., p. 285, pl. 24, fig. 4, 5.
?1948. *Loxostoma applinae* (PLUMMER); F. BROTZEN, The Swedish Paleocene..., p. 66, pl. 10, fig. 11.

1951. *Loxostomum applinae* (PLUMMER) NUTTALL; J. A. CUSHMAN, Paleocene Foraminifera..., p. 43, pl. 12, fig. 18 (earlier synonymy included).
non 1953. *Loxostomum applinae* (PLUMMER); L. W. LE ROY, Biostratigraphy..., p. 37, pl. 8, fig. 1.
1955. *Loxostoma applinae* (PLUMMER); J. CUVILLIER & F. DALBIEZ, Etudes micropaléontologiques..., text-fig. 14*a-b*.
non 1956. *Loxostomum applinae* (PLUMMER); A. F. M. HAQUE MOHSENUL, The Foraminifera..., p. 134, pl. 15, fig. 24-25.
non 1959. *Loxostomum applinae* (PLUMMER); S. E. NAKKADY, Biostratigraphy..., p. 459, pl. 2, fig. 1*a-b*.
1962. *Loxostomum applinae* (PLUMMER); M. E. SCHMID, Die Foraminiferenfauna..., p. 334, pl. 3, fig. 7.

Material. — About 40 specimens, often damaged.
Dimensions of an average specimen (in mm.):

Length of test	0·58
Maximum width of test	0·20

Description. — Test very elongated, slender, somewhat compressed, gradually tapering. Both ends of test and margins rounded. Ratio of length to width 5 : 1. Earlier portion of test distinctly biserial, remainder of test tending slightly to become somewhat uniserial, sides of adult portion nearly parallel. Chambers numerous, distinct, increasing rather regularly in size as added, sutures distinct, in early portion somewhat limbate, later depressed and crenulate, very slightly oblique. Wall smooth. Aperture: an elongated, oval opening, extending from near the apex downwards on the inner part of the last formed chamber.

Variation. — Sutural crenulation varies, being more distinct, less distinct or even indistinct.

Remarks. — This species is characteristic for the Paleocene of America as well as of Europe. Described also from Pakistan by HAQUE (1956, p. 135, pl. 15, fig. 24-25), but here it is ornamented with longitudinal costae, never present in a true *Loxostomum applinae* (PLUMMER). It is therefore rather varietas *L. aegyptiaea* NAKKADY (1950) and the arrangement of chambers tends very soon to be uniserial. Swedish specimens have not so distinct sutural crenulation as Polish specimens. The same is the case with *Loxostomum applinae* (PLUMMER) described by LE ROY (1953, pl. 8, fig. 1), where the author himself refers this form to *L. applinae* (PLUMMER) var. *aegyptiaea* NAKKADY (1950). To the same varietas one should include the specimen figured by NAKKADY in 1959 (pl. 2, fig. 1) and a BROTZEN's *Loxostoma applinae* (1948), which is very far from a typical *L. applinae*.

Distribution. — Rare in Montian at Bochotnica, Góra Puławska, Magnuszew, Nasiłów, Pamiętowo, Sochaczew and Żyrzyn. More common in Magnuszew. Present in Paleocene of America, as well as in Paleocene of Mediterranean Region. Not known from the Danian, except Austria (SCHMID, 1962, pl. 3, fig. 7), where strata under discussion seem to be rather of Paleocene, not of Danian age.

Loxostomum deadericki CUSHMAN, 1947

(Plate XV, fig. 12)

1947. *Loxostomum deadericki* CUSHMAN; J. A. CUSHMAN, Some new Foraminifera..., p. 85, pl. 18, fig. 8-10.
1951. *Loxostomum deadericki* CUSHMAN; J. A. CUSHMAN, Paleocene Foraminifera..., p. 44, pl. 12, fig. 21-23.

Material. — About 60 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·45
Maximum width of test	0·14

Description. — Test minute, elongated, slender, early portion biserial, somewhat twisted, the remainder of test uniserial. Chambers distinct, slightly inflated, increasing very gradually in size as added. Sutures distinct, slightly depressed, earlier ones straight, last formed gently curved. Wall smooth. Aperture a narrow slit.

Remarks. — Our specimens do not differ from American ones.

Distribution. — Rare in Danian, at Sochaczew only; common in Montian at Bochotnica, Góra Puławska, Nasiłów and Sochaczew. Common in Paleocene of America.

Genus **BULIMINA** D'ORBIGNY, 1826

Bulimina ovata D'ORBIGNY, 1846

(Plate XV, fig. 10)

1846. *Bulimina ovata* D'ORBIGNY; A. D'ORBIGNY, Foraminifères fossiles..., p. 185, pl. 11, fig. 13, 14.
1932. *Bulimina ovata* D'ORBIGNY; J. A. CUSHMAN & G. M. PONTON, An Eocene..., p. 67, pl. 9, fig. 1, 2.
1941. *Bulimina ovata* D'ORBIGNY; L. D. TOULMIN, Eocene smaller Foraminifera..., p. 597, pl. 80, fig. 25, 26.
1948. *Bulimina* aff. *ovata* D'ORBIGNY; F. BROTZEN, The Swedish Paleocene..., p. 59, pl. 10, fig. 9, 10.
1952. *Bulimina ovata* D'ORBIGNY; C. W. DROOGER, Foraminifera..., p. 95.
1953. *Bulimina ovata* D'ORBIGNY; N. K. BYKOVA, Foraminifery..., p. 68, pl. 2, fig. 4-6.
1953. *Bulimina ovata* D'ORBIGNY; N. N. SUBBOTINA, Verchne-eocenovye lagenidy..., p. 210, pl. 9, fig. 15, 16.
1954. *Praeglobulimina ovata* (D'ORBIGNY); J. HAYNES, Taxonomic position..., p. 190, text-fig. 9-12, 17-19.

Material. — About 200 specimens, often damaged.
Dimensions of an average specimen (in mm.):

Length of test	0·66
Maximum width of test	0·38

Description. — Test elongated, ovate to fusiform in outline, acute at initial end, broadly rounded at apertural end, tapering gently towards each end, almost circular in transverse section, greatest width above middle. Chambers distinct, slightly elongated, somewhat inflated. Sutures distinct, slightly depressed. Wall smooth. Aperture, a narrow slit on inner side of last chamber.

Variation. — In length/width proportion, which is rather large.

Remarks. — None of our specimens are so slender as the holotype, the size of chambers increasing more rapidly than in all American specimens.

Distribution. — Common in Danian and in Montian in all studied localities. Known from Upper Maastrichtian up to Upper Eocene in Europe, as well as in America.

Bulimina paleocenica BROTZEN, 1948

(Plate XV, fig. 4)

1948. *Bulimina (Reussella) paleocenica* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 61, pl. 6, fig. 5, 6.
1953. *Bulimina paleocenica* BROTZEN; N. K. BYKOVA, Foraminifery..., p. 70, pl. 2, fig. 7, text-fig. 3, 4.
1960. *Bulimina (Reussella) paleocenica* BROTZEN; J. HOFKER, Foraminifera..., p. 17, pl. 47.
1963. *Reussella paleocenica* (BROTZEN); O. K. KAPTARENKO-ČERNOUSOVA *et al.*, Atlas..., p. 165, pl. 30, fig. 1.

Material. — About 80 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·38
Maximum width of test	0·16

Description. — Test elongated, triangular in transverse section, slowly increasing in breadth. Acute at initial end, broadly rounded at apertural end. Angles rounded, sides slightly concave, chambers numerous, as high as long, of uniform shape throughout test. Sutures distinct, slightly depressed. Wall smooth. Aperture comma-shaped at the base of last formed chamber.

Variation. — Described by BROTZEN (1948) as well as its affinities with other species.

Remarks. — Our specimens do not differ from those of Sweden.

Distribution. — Not common in Danian and Montian at Boryszew, Góra Puławska, Sochaczew and Żyrzyn. This species occurs in the uppermost Danian and Lower Paleocene in Denmark and Sweden, the Netherlands, and in the south regions of Russian Platform.

Genus **PYRAMIDINA** BROTZEN, 1940

Pyramidina crassa BROTZEN, 1948

(Plate XV, figs. 5*a-c*)

1948. *Pyramidina crassa* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 63, pl. 6, fig. 8.
1961. *Pyramidina crassa* BROTZEN; G. E. AIZENŠTADT & I. A. PINČUK, Opornye skvažiny..., p. 215.

Material. — 25 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·41
Maximum width of test	0·18

Description. — Test tapering, twice as long as broad, greatest breadth towards the apertural end, initial end angular, blunt, triangular in the transverse section, peripheral margins broadly rounded. Sides slightly depressed. Chambers numerous, 5-6 in each row, rapidly increasing in size as added, gently inflated. Sutures distinct, strongly curved, lobate, slightly depressed. Wall smooth. Aperture terminal.

Variation. — Applies to sides which can be flat or depressed, and to general outline of test, more or less slender.

Remarks. — Its close relation with *Pyramidina curvisuturata* BROTZEN from the Danian was noted by BROTZEN himself (1948). Our specimens do not differ from the holotype.

Distribution. — Not very common in Danian at Sochaczew and Żyrzyn, more common in Montian at Bochotnica, Góra Puławska, Magnuszew, Nasiłów, Pamiętowo, Sochaczew and Żyrzyn. Known from Sweden and south regions of U. S. S. R. Present in Austria.

Genus **ANGULOGERINA** CUSHMAN, 1927

Angulogerina cuneata BROTZEN, 1948

(Plate XV, figs. 7*a-c*)

1948. *Angulogerina cuneata* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 64, pl. 6, fig. 10.
1957. *Angulogerina cuneata* BROTZEN; F. BROTZEN & K. POŻARYSKA, The Paleocene in central Poland, p. 274.

Material. — Over 200 hundred specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·40
Maximum width of test	0·18

Description. — Test tapering, twisted or warped, about twice as long as broad, greatest breadth towards apertural end, initial end angular, apertural end broadly rounded, triangular in transverse section, peripheral margins truncated with double keels on early portion of test. Chambers broad, inflated, rapidly increasing in size as added. Sutures distinct, slightly depressed, lobate. Wall smooth. Aperture terminal.

Variation. — Considerable, studied by BROTZEN (1948).

Remarks. — Relations with *Pyramidina crassa* BROTZEN on the one hand, and with *Angulogerina (Uvigerina) cristata* (MARSSON) and *A. wilcoxensis* CUSHMAN & PONTON on the other hand, have been discussed by BROTZEN (1948).

Distribution. — Common in Danian as well as in Montian at Bochotnica, Góra Puławska, Boryszew, Pamiętowo, Sochaczew and Żyrzyn. This species occurs rarely in Lower Paleocene of Sweden.

Family BOLIVINITIDAE CUSHMAN, 1927
(nom. transl. N. BYKOVA, 1959, ex BOLIVINITINAE CUSHMAN, 1927)

Genus **BOLIVINOIDES** CUSHMAN, 1926

Bolivinoides polonica PŻARYSKA, 1954

(Plate XIV, fig. 2)

1954. *Bolivinoides polonica* PŻARYSKA; K. PŻARYSKA, O przewodnich otwornicach..., p. 63, text-fig. 1.
1956. *Bolivinoides polonica* PŻARYSKA; J. HOFKER, Foraminifera from the Cretaceous..., XV, p. 28, pl. 2.
1959. *Bolivinoides polonica* PŻARYSKA; J. HOFKER, Les Foraminifères..., p. 8.

Material. — About 100 specimens, often damaged.
Dimensions of an average specimen (in mm.):

Length of test	0·22
Maximum width of test	0·18

Description. — Test flattened, outline rhomboidal, elongated downwards. Margins rounded. Ratio of length to width 1 : 2. Upper margin of test rounded and thickened, thickening extending downwards in six to eight short ridges, with deep grooves between. Median and lower parts of test usually lack ornamentation; surface however is rather uneven and rough, with irregular shallow indentations or even some isolated, irregular knobs. Minute isolated tubercles sometimes present on extended ridges, disappearing in lower part of test. Sutures between chambers completely invisible. Ornamentation on both sides of test uniform. Proloculum indistinguishable or very slightly inflated. Aperture somewhat elongated, on upper end of test, at the base of last septal face.

Variation. — There is a great range of variation in this species, applying mainly to irregular ornamentation.

Distribution. — Rare in Danian as well as in Montian at Bochotnica, Góra Puławska and Sochaczew. Found in Upper Maastrichtian *(Md)* and in Danian *(Me)* in Limburg and in Cotentin Peninsula (HOFKER, 1959).

Bolivinoides vistulae POŻARYSKA, 1954

(Plate XIV, fig. 1)

1954. *Bolivinoides vistulae* POŻARYSKA; K. POŻARYSKA, O przewodnich otwornicach..., p. 64, text-fig. 2.

Material. — About 2000 specimens, half of them damaged.
Dimensions of an average specimen (in mm.):

Length of test	0·23
Maximum width of test	0·18

Description. — Test flattened, outline rhomboidal, with lower end elongated, kite-shaped Margins acute. Ratio of length to width 2 : 3. Upper margin of test somewhat broadly rounded, thickened. Sutures between chambers invisible. Proloculum large, distinctly outlined. Surface of test ornamented, the sculpture consisting of protuberant knobs, which are arranged longitudinally in four rows, number of rows decreasing to three or even two in lower portion of test. The knobs oval in outline, elongated, parallel to length of test. Their size diminishing downwards. Aperture somewhat elongated, on upper end of test, at base of last septal face. Wall glistening, porcellaneous.

Variation. — Between the two central rows of tubercles sometimes an elongated, narrow depression not considerable, forming a little furrow. Some specimens are more elongated, slender, some shorter, more rhomboidal. Often they are somewhat warped at the earlier portion of test. Rarely are the tubercles on the initial part of test lacking.

Remarks. — This species resembles somewhat *Bolivinoides peterssoni* BROTZEN, from which it differs in having more strongly developed knobs and completely invisible sutures between chambers.

Distribution. — Very common in Danian at Góra Puławska and Żyrzyn, less common in Montian at Bochotnica, Góra Puławska and Sochaczew. Very rare in the Maastrichtian at Żyrzyn.

Genus **BOLIVINITA** CUSHMAN, 1927

Bolivinita oedumi (BROTZEN, 1948)

(Plate XV, fig. 13)

1948. *Bolivina ödumi* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 65, pl. 9, fig. 3-4.

Material. — Some specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·34
Maximum width of test	0·18

Description. — Test minute, elongated, slowly tapering to the initial end which is broadly rounded, sides flat, periphery slightly lobate, acute, greatest width formed by two last chambers. Chambers distinct, compressed, arranged biserially, increasing gradually in size as added, numerous, up to 13 in number. Sutures distinct, slightly depressed, straight or gently curved. Wall smooth.

Variation. — Not known due to scarcity of material.

Remarks. — Our specimens seem to be very similar to those described by BROTZEN (1948).

Distribution. — Very rare in Danian at Pamiętowo boring, and in Montian in Pamiętowo and Żyrzyn. Described from Lower Paleocene in Sweden.

Genus **TAPPANINA** MONTANARO-GALLITELLI, 1955

Tappanina selmensis (CUSHMAN, 1933)

(Plate XV, fig. 9)

1933. *Bolivinita selmensis* CUSHMAN; J. A. CUSHMAN, New American Cretaceous..., p. 58, pl. 7, fig. 3, 4.
1948. *Bolivinita selmensis* CUSHMAN; F. BROTZEN, The Swedish Paleocene..., p. 56, pl. 9, fig. 7, text-fig. 16.
1957. *Tappanina selmensis* (CUSHMAN); E. MONTANARO-GALLITELLI, A revision..., p. 147, pl. 33, fig. 21*a-b*,
1962. *Tappanina selmensis* (CUSHMAN); M. E. SCHMID, Die Foraminiferenfauna..., p. 334, pl. 6, fig. 10.

Material. — About 50 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·75
Maximum width of test	0·31

Description. — Test minute, elongated, rhomboidal or rectangular in transverse section, gently tapering to an subacute initial end, sides flattened, distinctly concave, periphery comparatively thick, truncated, slightly convex, lobate. Apertural margin of test rounded, thickened and strongly convex. Chambers numerous, distinct, gradually increasing in size as added. Sutures distinct, limbate, strongly raised, in the adult each chamber has a sharp angle, which may be developed into a strongly raised costa-like ridge. Wall smooth, aperture narrow at the inner margin of last formed chamber.

Variation. — Studied in detail by BROTZEN (1948). There is a great range of variation in this species.

Remarks. — Our specimens do not differ from the Swedish ones.

Distribution. — Common in Danian and in Montian at Góra Puławska, Pamiętowo, Sochaczew and Żyrzyn. Described by CUSHMAN (1933) from Upper Cretaceous of America. Common in Swedish Maastrichtian-Paleocene beds, as well as in Danish Paleocene. Present in Danian (?) of Austria.

Genus **BOLIVINITELLA** MARIE, 1941

Bolivinitella eleyi (CUSHMAN, 1927)

(Plate XV, fig. 2)

1927. *Bolivinita eleyi* CUSHMAN; J. A. CUSHMAN, American Upper Cretaceous species of Bolivina, p. 91, pl. 12, fig. 11*a-b*.
1941. *Bolivinitella Eleyi* (CUSHMAN) forma typica MARIE; P. MARIE, Les Foraminifères..., p. 190, pl. 29, fig. 282*d-c*.
1957. *Bolivinitella eleyi* (CUSHMAN); E. MONTANARO-GALLITELLI, A revision..., p. 150, pl. 34, fig. 14-17.

Material. — A dozen or so specimens.
Dimensions of an average specimen (in mm.):

Length of test	0·31
Maximum width of test	0·14

Description. — Test minute, elongated, compressed, somewhat rhomboidal, tapering to the initial end, biserial throughout, rectangular in section, sides flat, periphery truncated, keeled (2 keels) somewhat concave, greatest width formed by two last chambers. Chambers distinct, reniform, increasing gradually in size as added, arranged biserially with a tendency to become uniserial, overlapping, numerous, up to 15 in number. Sutures very distinct, limbate, strongly raised, straight in the early portion, curved in the remainder of test, becoming sickled. Wall smooth, except for sutures. Aperture terminal, linear or elliptical.

Remarks. — Very close to the specimens described by MARIE (1941) from the Cretaceous of Paris Basin. Similar to *Bolivinita planata* CUSHMAN (1927) from the Navarro formation of Texas, and Maastrichtian of Mangyszlak peninsula (VASILENKO, 1961). It seems that this latter species is the same as *Bolivinitella eleyi* CUSHMAN. This species has been discussed in detail by MONTANARO-GALLITELLI (1957).

Distribution. — Rare in Danian at Góra Puławska and Sochaczew; very rare in Montian. Probably reworked from the Maastrichtian. Known from Cretaceous of America and Paris Basin.

Genus **BOLIVINA** D'ORBIGNY, 1839

Bolivina subincrassata CHALILOV, 1956

(Plate XV, figs. 11*a-b*)

1956. *Bolivina subincrassata* CHALILOV; D. M. CHALILOV, Novye vidy..., p. 181, pl. 1, fig. 1.

Material. — Some dozens specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	1·20
Maximum width of test	0·33
Thickness of test	0·22

Description. — Test strong, elongated, peripheral margins nearly parallel, broadly rounded as well as the initial aperture ends, slightly tapering towards the apertural end, oval in transverse section, outline not lobulate. Chambers numerous, up to 10 in one row, biserially arranged, proloculus large, circular, chambers not inflated, rectangular or even trapezoidal in shape, of uniform shape, gradually increasing in size as added. Sutures distinct, straight, flush with surface, obliquely meeting the periphery, at right angles to each other. Wall smooth. Aperture, a distinct slit extending from the suture towards the top of last formed chamber.

Remarks. — This species differs from *Bolivina incrassata* in having quite straight sutures, parallel margins, from *Bolivina tegulata* HOFKER — in not having lobular margins, or crescent shaped chambers, from *B. basbeckensis* HOFKER — in having not inflated chambers. Our specimens are most similar to *B. subincrassata* CHALILOV (1956).

Distribution. — Common in Danian and Montian in all studied localities, excluding Bochotnica, described as common from Danian and Paleocene of Azerbajdžan (U. S. S. R.).

Family DISCORBIDAE CUSHMAN, 1927
(nom. transl. GLAESSNER, 1945, ex DISCORBISINAE CUSHMAN, 1927)

Genus **DISCORBIS** LAMARCK, 1804

Discorbis limbata (TERQUEM, 1882)

(Plate XVII, figs. 1*a-c*)

1882. *Rotalina limbata* TERQUEM; O. TERQUEM, Les Foraminifères..., p. 80, pl. 8, fig. 6*a-c*.
1949. *Discorbis limbata* (TERQUEM); Y. LE CALVEZ, Révision des Foraminifères..., p. 19, pl. 2, fig. 30-32.

Material. — A few specimens, damaged.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·43
Shortest diameter of test	0·36
Height of test	0·05

Description. — Test plano-convex, very strongly compressed, nearly flat on both sides, peripheral margin acute, keeled, slightly lobate. Ventral side quite flat, chambers distinct, very slightly inflated, up to 5 in last whorl, increasing rapidly in size as added. The last chamber very large, covering the earlier whorls. Sutures sickled, depressed. The dorsal side slightly convex, 8 chambers visible, the last ones elongated, nearly crescent. Sutures limbate, gently curved. Wall smooth, the edge with a keel which is a prolongation of sutures; wall very finely perforated on both sides. Aperture, an elongated slit, sometimes crescent at the base of last formed chamber, on the ventral side.

Variation. — Not known because of the scarcity of material.

Remarks. — Our specimens differ from the holotype, described from the Eocene of Paris Basin, only in general shape of the test, being flatter on dorsal side.

Distribution. — Very rare in Montian at Boryszew only. Known from the Eocene, upper part of »Calcaire grossier« in Paris Basin.

Discorbis ubiqua LE CALVEZ, 1949

(Plate XXII, figs. 4*a-c*)

pars 1882. *Rotalina turbinata* TERQUEM; O. TERQUEM, Les Foraminifères..., p. 75, non pl. 7, fig. 5*a-b*.
1949. *Discorbis ubiqua* nom. nov.; Y. LE CALVEZ, Révision des Foraminifères..., p. 23, pl. 2, fig. 27-29.

Material. — Few specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·30
Shortest diameter of test	0·24
Height of test	0·11

Description. — Test plano-convex, outline nearly circular, moderately compressed, ventral side even gently concave, dorsal side slightly convex, peripheral margin broadly rounded. Chambers distinct, gradually increasing in size as added, up to 5-6 in last whorl. Sutures distinct, limbate on dorsal side, curved and slightly depressed, non-limbate on ventral side and deeply depressed. Umbilical depression large, covered by an umbilical plate. Wall smooth on ventral side, coarsely perforated on dorsal side. Aperture ventral quite near the umbilicus, loop-shaped, with a very narrow lip.

Variation. — Not known, due to the scarcity of material.

Remarks. — Our specimens differ from the French ones in having more chambers in the last whorl, up to 6, instead of only 4, and are not so high on the dorsal side. Specimen figured by LE CALVEZ (1949, pl. 2, fig. 29) shows the umbilicus quite open (probably damaged), while some of our specimens have a regular umbilical plate, entirely covering the umbilicus.

Distribution. — Rare in the Montian at Sochaczew. This species was described and revised by LE CALVEZ (1949) from the Middle Eocene of Paris Basin. Not known from the Montian there.

Genus **ROSALINA** D'ORBIGNY, 1826

Rosalina crenulata HOFKER, 1962

(Plate XVI, figs. 2*a-c*)

1962. *Rosalina crenulata* HOFKER; J. HOFKER, Foraminifera from the Cretaceous..., LVII, p. 11, text-fig. 5*a-c*.

Material. — Few specimens, well preserved.

Dimensions of an average specimen (in mm.):

Longest diameter of test	0·33
Shortest diameter of test	0·29
Height of test	0·14

Description. — Test small, elliptical, dorsal side convex, ventral side flat or even slightly concave. Peripheral margin subacute. At the dorsal side chambers are low, strongly elongated, crescent, and sutures strongly curved, flush with the surface. Chambers on ventral side slightly inflated, sutures distinct, depressed, leaving a small umbilical hollow free, filled with small tubercles which sometimes can be found on the sutures too. Last formed chamber with distinct tooth in the central part. Wall smooth. Fine pores on the ventral side.

Variation. — Only in the crenulation of sutures which is often absent in Polish specimens.

Remarks. — Our specimens differ from the holotype described from the Limburg in the character of sutures on dorsal side which are smooth, not crenulated.

Distribution. — Rare in Danian as well as in Montian at Bochotnica, Góra Puławska, Pamiętowo, Sochaczew and Żyrzyn. Rare in Danian, HOFKER's Lower Paleocene, at Limburg.

Genus **CONORBINA** BROTZEN, 1936

Conorbina? sp. or **Neoconorbina** sp.

(Plate XVI, figs. 4*a-c*)

1951. *Patellinoides?* sp.; J. A. CUSHMAN, Paleocene Foraminifera..., p. 48, pl. 13, fig. 19.

Material. — Some specimens, well preserved.

Dimensions of an average specimen (in mm.):

Longest diameter of test	0·38
Shortest diameter of test	0·36
Height of test	0·20

Description. — Test conical, rather high, outline circular or somewhat oval, very slightly lobulate. Dorsal side strongly convex, ventral side slightly concave. Nearly 2 whorls visible on dorsal side. Individual chambers indistinct, gently inflated on ventral side, while on dorsal

side chambers distinctly, rhomboidal, the last tending to be crescent. Sutures strongly oblique, curved, distinctly raised on dorsal side, not visible on ventral. Aperture, a large irregular cavity, partly covered by a rectangular plate-like lip, ragged in outline. Wall smooth, glistening on ventral side.

Remarks. — A very similar species is noted from the Montian of Limburg and Paris Basin by P. MARIE (oral information) and a single specimen from the Paleocene of North America (Naheola), not identified by CUSHMAN (1951). Few specimens found in Polish Montian are referred tentatively to the genus *Conorbina*. Similar to *Conorbina conula* BROTZEN described from Swedish Upper Danian (BROTZEN, 1940), differing from our specimen in having nearly twice more whorls on dorsal side.

Distribution. — Very rare in Montian at Góra Puławska and Pamiętowo.

Genus **VALVULINERIA** CUSHMAN, 1926

Valvulineria ravni BROTZEN, 1948

(Plate XVIII, figs. 2*a-c*)

1948. *Valvulineria ravni* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 74, pl. 9, fig. 13.
1963. *Valvulineria ravni* BROTZEN; J. HOFKER, Foraminifera from the Cretaceous..., LXIII, p. 6, text-fig. 1.

Material. — Few specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·43
Shortest diameter of test	0·40
Height of test	0·17

Description. — Test nearly biconvex, ventral side more convex, periphery broadly rounded, distinctly lobate, especially in the last portion of coiling. Centre of dorsal side depressed. $2^1/_2$ spires on dorsal side. 9-10 chambers in last whorl. Chambers inflated, sutures radiating, distinctly depressed. Umbilical depression covered by a small lip. Wall smooth, very finely perforated. Aperture, a narrow slit extending from the peripheral margin up to the umbilicus at the base of the last formed chamber.

Variation. — Together with discussion and similarity to other species, given by BROTZEN (1948) and HOFKER (1963).

Remarks. — Our specimens are quite the same as those described by BROTZEN (1948) from the Swedish Paleocene.

Distribution. — Rare in Montian at Sochaczew and Boryszew. Known from the Swedish and Danish Paleocene where is rarely too, and in Curfs quarry (Limburg).

Genus **GLOBOROTALITES** BROTZEN, 1942

Globorotalites cf. **lobata** BROTZEN, 1948

(Plate XVII, figs. 3*a-c*)

1948. *Globorotalites lobata* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 91, pl. 17, fig. 3.

Material. — A few specimens, partly damaged.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·44
Shortest diameter of test	0·36
Thickness of test	0·14

Description. — Test small, conical, outline circular or slightly oval, strongly lobulate, korsal side flat or slightly convex, ventral side convex. Peripheral margin sharply angulate, deeled. Chambers flat, crescent on dorsal side, 6 in number in last whorl, while on ventral side chambers are triangular, strongly inflated. Umbilicus missing. Sutures distinct, oblique, strongly curved, limbate on dorsal side, radial, slightly curved, depressed on ventral side. Keel narrow, formed by raised sutures on dorsal side extending along the periphery. Aperture, an elongated slit under a narrow lip, extending on ventral side from the periphery up to the middle of test. Wall smooth.

Variation. — Not known due to scarcity of material.

Remarks. — Our specimens do not differ significantly from the holotype, having more chambers in the last whorl (6 instead of 4), and having a less convex ventral side.

Distribution. — Very rare in Montian at Boryszew and Sochaczew.

Genus **GYROIDINOIDES** BROTZEN, 1942

Gyroidinoides octocamerata CUSHMAN & HANNA, 1927

(Plate XVIII, figs. 3*a-c*, 5*a-c*)

1927. *Gyroidina soldanii* D'ORBIGNY subsp. *octocamerata* CUSHMAN & HANNA; J. A. CUSHMAN & G. D. HANNA, Foraminifera from the Eocene near Coalinge, p. 223, pl. 14, fig. 16-18.

pars 1941. *Gyroidina soldanii* D'ORBIGNY var. *octocamerata* CUSHMAN & HANNA; L. TOULMIN, Eocene smaller Foraminifera..., p. 600, pl. 81, fig. 3-5 (earlier synonymy included).

1948. *Gyroidinoides soldanii* (D'ORBIGNY) var. *octocamerata* (CUSHMAN & HANNA); F. BROTZEN, The Swedish Paleocene..., p. 76, pl. 11, fig. 3.

1953. *Gyroidina octocamerata* CUSHMAN & HANNA; E. V. MJATLJUK, Spirillinidy..., p. 60, pl. 4, fig. 7-8.

1956*a*. *Gyroidinoides octocamerata* CUSHMAN & HANNA; J. HOFKER, Les Foraminifères..., p. 197B.

?1961. *Gyroidina soldanii* ORBIGNY; A. V. FURSENKO & R. B. FURSENKO, Foraminifery verchnego eocena..., p. 278, pl. 4, fig. 4.

Material. — Some dozen of specimens, well preserved.
Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	0·31	0·64
Shortest diameter of test	0·26	0·52
Height of test	0·19	0·40

Description. — Test small, dorsal side flattened, almost flat, ventral side very convex, subcircular in outline, slightly lobate, periphery angled. Nearly 2 whorls can be identified on dorsal side. Chambers distinct, inflated, 8 in last whorl, increasing regularly in size as added; sutures distinct, straight on ventral side, somewhat oblique, sometimes gently curved on dorsal side, slightly depressed, especially in later portion of test. Umbilical region strongly depressed. Wall smooth, very finely perforated. Aperture, a low opening at base of the last formed chamber, extending from the periphery to the umbilical part on the ventral side, sometimes covered by a flattened lip extending over the umbilicus.

Variation. — Applies to sutures which sometimes are more strongly depressed, sometimes almost not depressed. In the first case the general outline is lobate, in the latter non-lobate.

Remarks. — Our specimens are very close to the holotype described from Eocene of California. Generally the umbilical lip is absent in Polish specimens. All other features are more or less the same.

Distribution. — Very common in Danian and in Paleocene in all studied samples from outcrops and borings. The first appearance of this species noted from the Upper Maastrichtian from »Żyrzyn beds« at Żyrzyn and at Pamiętowo. In America known from the Eocene. In Europe first appearing in Upper Maastrichtian, common in Danian and very common in Paleocene.

Gyroidinoides pontoni BROTZEN, 1948

(Plate XVIII, figs. 4*a-c*)

1948. *Gyroidinoides pontoni* BROTZEN, F. BROTZEN, The Swedish Paleocene..., p. 76, pl. 11, fig. 4-5.

Material. — About 200 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·37
Shortest diameter of test	0·31
Height of test	0·16

Description. — Test somewhat biconvex, dorsal side slightly convex, ventral side strongly convex, periphery broadly rounded. $2^1/_2$ spires on dorsal side, 10 chambers distinct in last whorl. Chambers of uniform shape, moderately increasing in size as added, sutures distinct, flush with surface, transparent, being somewhat limbate on the inner part of each whorl. Oblique on dorsal side, radial on ventral side, gently curved on both sides. Umbilicus narrow, covered by a lip extending from last chamber. Wall smooth. Aperture, double loop-shaped at the base of the last formed chamber.

Variation. — Recorded by BROTZEN (1958).

Remarks. — Specimens from Poland differ from the holotype in not having depressed sutures between last chambers and having somewhat limbate sutures on the inner part of all whorls. This species has 10 chambers in last whorl, instead of 8, as in *Gyroidinoides soldanii octocamerata*. Its margin is broadly rounded, while in *G. soldanii octocamerata* it is angled and the dorsal side is nearly flat.

Distribution. — Common in almost all studied samples from the Danian and Montian at Bochotnica, Boryszew, Góra Puławska, Pamiętowo, Sochaczew and Żyrzyn. Described from the Paleocene (Selandian) of Sweden.

Gyroidinoides subangulata (PLUMMER, 1926)

(Plate XVIII, figs. 1*a-c*)

1926. *Rotalia soldanii* (D'ORBIGNY) var. *subangulata* PLUMMER; H. J. PLUMMER, Foraminifera of the Midway..., p. 154, pl. 12, fig. 1*a-c*.
1951. *Gyroidina subangulata* (PLUMMER) CUSHMAN; J. A. CUSHMAN, Paleocene Foraminifera..., p. 51, pl. 14, fig. 14, 15.
1953. *Gyroidina subangulata* (PLUMMER); E. V. MJATLJUK, Spirillinidy..., p. 59, pl. 4, fig. 3, 4.
1953. *Gyroidina subangulata* (PLUMMER); L. W. LE ROY, Biostratigraphy..., p. 35, pl. 3, fig. 23-25.
1956. *Gyroidina subangulata* (PLUMMER); R. SAID & A. KENAWY, Upper Cretaceous..., p. 149, pl. 5, fig. 9.
1958. *Gyroidinoides subangulata* (PLUMMER); J. HOFKER, Foraminifera from the Cretaceous..., XXXIII, p. 43, text-fig. 7, 8.

1960. *Gyroidinoides subangulata* (PLUMMER); R. K. OLSSON, Foraminifera..., p. 36, pl. 5, fig. 24, 25.
1961. *Gyroidina subangulata* PLUMMER; V. P. VASILENKO, Foraminifery verchnego mela..., p. 229.
1962. *Gyroidinoides subangulata* (PLUMMER); M. E. SCHMID, Die Foraminiferenfauna..., p. 341, pl. 5, fig. 3, 4.

Material. — A dozen or so specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·47
Shortest diameter of test	0·41
Height of test	0·29

Description. — Test almost plano-convex, outline circular, unlobate, peripheral margin angular, rather blunt, ventral side strongly convex, dorsal side flat, composed of about two whorls. Chambers distinct, gently inflated, of rather uniform shape, moderately increasing in size as added, up to 8-9 in the last formed whorl. Sutures distinct, straight, radiate, flush with surface on both sides and around the umbilical depression which is distinct and deep. Sutures oblique on dorsal side. Wall smooth, finely perforated. Aperture, a long, narrow slit at the base of the last formed chamber, extending from the umbilical depression up to the margin of test.

Variation. — Not significant, a very distinctive species.

Remarks. — Umbilical depression can be sometimes covered by a tenon. HOFKER observed this in specimens from Limburg region (1958). Polish specimens have less chambers in the whorl, commonly 8, sometimes $8^1/_2$ as in the holotype from Midway, never 10 as observed by HOFKER. This species is somewhat similar to *Gyroidina girardana*, described by REUSS from Cretaceous of Germany.

Distribution. — Rare in Maastrichtian, not common in Danian at Bochotnica, and in Montian at Boryszew, Góra Puławska and Sochaczew. Not common in the Upper Maastrichtian at Limburg region, more commonly found in Danian as well as in all Kunrade chalk. Common in the Paleocene of Sinai (Egypt), in the Midway formation, in Georgia (U. S. S. R.) too. Present in Danian (?) of Austria.

Genus **EPONIDES** MONTFORT, 1808

Eponides frankei BROTZEN, 1940

(Plate XXI, figs. 2*a-c*)

1940. *Eponides frankei* BROTZEN; F. BROTZEN, Flintränna̲ns..., p. 32, pl. 8, fig. 3*a-c*.
1953. *Eponides frankei* BROTZEN; E. V. MJATLJUK, Spirillinidy..., p. 100, pl. 8, fig. 8*a-v*.
1961. *Eponides frankei* BROTZEN; V. S. AKIMEC, Stratigrafija i foraminifery..., p. 132, pl. 12, fig. 5*a-v*.

Material. — A dozen or so specimens.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·40
Shortest diameter of test	0·35
Thickness of test	0·22

Description. — Test biconvex, lenticular, strongly convex on both sides. Outline round, circular, not lobulate, peripheral margin angulate. 3-4 low whorls on dorsal side, 6 chambers in last whorl. Chambers crescent on dorsal side, slightly inflated, triangular on ventral side. Sutures oblique, slightly curved on dorsal side, flush with surface, visible only on last

whorl, while the centre of dorsal side forms an elevation resembling a well developed plug; on ventral side sutures distinct, radial, very slightly depressed. Umbilicus missing. Aperture, a narrow, elongated slit at the base of the last formed chamber on ventral side. Wall smooth.

Variation. — Not known, due to the scarcity of material.

Remarks. — Our specimens do not differ from the holotype described by BROTZEN (1940).

Distribution. — Rare in Upper Maastrichtian at Góra Puławska, Żyrzyn, Sochaczew and Pamiętowo. Known from Maastrichtian and Danian in Sweden, in Upper Campanian and Maastrichtian of Donetz Basin, peninsula Mangyšlak, Wolga region and Lwów (Lvov) in U. S. S. R., and from Danian of Trinidad.

Eponides lunata BROTZEN, 1948

1948. *Eponides lunata* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 77, pl. 10, fig. 17, 18.
1950. *Cibicides(?) lunatus* (BROTZEN); V. P. VASILENKO, Foraminifery paleocena..., p. 220, pl. 6, fig. 6.
1953. *Eponides lunatus* (BROTZEN); L. W. LE ROY, Biostratigraphy..., p. 30, pl. 9, fig. 24-26.
1954. *Cibicides (Gemellides) lunatus* (BROTZEN); V. P. VASILENKO, Anomalinidy, p. 188, pl. 33, fig. 4*a-v*.
1960. *Eponides lunata* BROTZEN; R. K. OLSSON, Foraminifera..., p. 36.
1963. *Cibicides (Gemellides) lunatus* (BROTZEN); O. K. KAPTARENKO-ČERNOUSOVA *et al.*, Atlas..., p. 146, pl. 30, fig. 7.

Material. — About 50 specimens, well preserved.
Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	0·22	0·39
Shortest diameter of test	0·21	0·34
Height of test	0·13	0·10

Description. — Test small, lenticular, biconvex, ventral side more convex, dorsal side less convex, outline circular, distinctly lobular, peripheral margin sharply acute. $3^1/_2$ whorls on dorsal side, 6-7 chambers in last whorl. Chambers crescent on dorsal side, triangular on ventral, in the latter slightly inflated. Sutures distinct, oblique, gently curved, flush with surface on dorsal side, slightly depressed on the ventral. Umbilicus missing. Wall smooth, finely perforated. Aperture, an elongated slit under a narrow lip along the base of the last formed chamber on ventral side.

Variation. — Described by BROTZEN (1948) and VASILENKO (1954).

Remarks. — Our specimens do not differ from the holotype.

Distribution. — Not common in uppermost Maastrichtian, Danian and Montian in almost all studied localities, except Boryszew and Sochaczew. This species occurs rarely in Swedish and Danish Paleocene, in Esna shale of Egypt, and in Paleocene of Donetz Basin and south regions of U. S. S. R., as well as in North America.

Eponides toulmini BROTZEN, 1948

(Plate XVII, figs. 4*a-c*)

1941. *Eponides boueana* D'ORBIGNY; L. D. TOULMIN, Eocene smaller Foraminifera..., p. 601, pl. 81, fig. 6-7.
1946. *Eponides gratus* (REUSS); R. C. VAN BELLEN, Foraminifera..., p. 57, pl. 7, fig. 4-9.
1948. *Eponides toulmini* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 78, pl. 10, fig. 16.

1951. *Pseudoparrella meeterenae* VISSER; A. M. VISSER, Monograph..., p. 278, pl. 7, fig. 9.
1956. *Eponides toulmini* (BROTZEN); J. HOFKER, Foraminifera from the Cretaceous..., XV, p. 29, text-fig. 4.
1956*b*. *Eponides toulmini* BROTZEN; J. HOFKER, Die Pseudotextularia-Zone..., p. 72, pl. 8, fig. 58.
?1956. *Eponides*? aff. *E. toulmini* BROTZEN; J. HAYNES, Certain smaller..., p. 94, pl. 17, fig. 7.
1961. *Globorotalites perforatus* VASILENKO; V. P. VASILENKO, Foraminifery verchnego mela..., p. 61, pl. 10, fig. 5.

Material. — Some hundred specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·55
Shortest diameter of test	0·44
Height of test	0·22

Description. — Test slightly oval, lenticular, outline slightly lobulate, unequally biconvex, ventral side more strongly convex than dorsal side. Peripheral margin subacute, carinate. Chambers distinct, 6 in number in last whorl, increasing regularly in size as added. On ventral side somewhat inflated, the last chamber lobate, a small umbilical depression in the centre, sutures radial depressed. On dorsal side 3 whorls not always visible, sutures slightly limbate, oblique, gently curved, nearly flush with surface. Wall smooth, distinctly and coarsely perforated on both sides to the same degree. Aperture, a narrow slit on ventral suture of the last formed chamber, covered by an irregular, narrow lip.

Variation. — This species shows a large range of variation, described by BROTZEN (1948) as well as by HOFKER (1956).

Remarks. — Our specimens are rather larger than those described by BROTZEN, and more coarsely perforated on both sides, thus differing from the holotype described from the Swedish Paleocene.

Distribution. — Very common in Danian as well as in Montian in almost all studied samples from outcrops and borings. Present in uppermost Maastrichtian in Góra Puławska and Sochaczew. Present and revised by HOFKER (1956) from the Upper Maastrichtian up to Montian in Germany, the Netherlands and Belgium. *Globorotalites perforatus* VASILENKO (1961), described from Danian of Mangyšlak peninsula (U. S. S. R.) does not differ and seems to be conspecific with *Eponides toulmini* BROTZEN.

Family SIPHONINIDAE CUSHMAN, 1928

Genus **PULSIPHONINA** BROTZEN, 1948

Pulsiphonina prima (PLUMMER, 1926)

(Plate XVI, fig. 3*a-c*, 6*a-c*)

1926. *Siphonina prima* PLUMMER; H. J. PLUMMER, Foraminifera of the Midway..., p. 148, pl. 12, fig. 4.
1944. *Siphonina prima* PLUMMER; C. L. COOPER, Smaller Foraminifera..., p. 353, pl. 55, fig. 7-9.
1948. *Pulsiphonina elegans* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 107, pl. 17, fig. 4.
1951. *Siphonina prima* PLUMMER; J. A. CUSHMAN, Paleocene Foraminifera..., p. 55, pl. 15, fig. 7-9 (earlier synonymy included).
1956. *Pulsiphonina prima* (PLUMMER); J. HAYNES, Certain smaller..., p. 96, pl. 17, fig. 9.
1958. *Pulsiphonina prima* (PLUMMER); J. HOFKER, Foraminifera from the Cretaceous..., XXXIII, p. 42, text-fig. 3, 4.
1960. *Pulsiphonina prima* (PLUMMER); R. K. OLSSON, Foraminifera..., p. 39, pl. 7, fig. 1-3.
1961. *Pulsiphonina elegans* BROTZEN; J. HOFKER, Foraminifera from the Cretaceous..., LIII, p. 67, text-fig. 11*a-c*.
1963. *Siphonina prima* PLUMMER; O. K. KAPTARENKO-ČERNOUSOVA *et al.*, Atlas..., p. 139, pl. 30, fig. 2.

Material. — Over one hundred specimens, well preserved. Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	0·34	0·32
Shortest diameter of test	0·27	0·29
Height of test	0·16	0·16

Description. — Test small, nearly circular, compressed, about equally biconvex, peripheral margin slightly lobate, sharply acute and delicately serrate. Small central depression on ventral side. 3 whorls on dorsal side. Chambers 4-5 in the last whorl, inflated on ventral side, crescent-shaped on dorsal side. Sutures radial, distinct, strongly oblique and flush with surface on dorsal side, depressed and curved on ventral side. Wall smooth, distinctly perforated. Aperture narrow, elliptical, with a lip opening on ventral side, just close to the periphery.

Variation. — Rather small, mainly in acute or subacute margin, and in presence or lack of the apertural lip.

Remarks. — Our specimens do not differ from the holotype described from Midway formation. It seems that *Pulvinulinella eklundi* BROTZEN (1940), described from the Swedish uppermost Maastrichtian and Danian, is at first sight very similar to *Pulsiphonina prima* (PLUMMER), differing only in the aperture being parallel to the test margin.

Distribution. — Very common in Danian and in Montian at Bochotnica, Nasiłów, Magnuszew, Góra Puławska, Żyrzyn, Sochaczew, Boryszew and Pamiętowo. Two specimens found in the Upper Maastrichtian at Góra Puławska. HOFKER mentioned (1958) some specimens of *Pulsiphonina prima* (PLUMMER), found as early as in the Maastrichtian Tuff Chalk (*Md*); this species is common in the Danian of Limburg (so-called *Me*), as well as in Tuffeau de Ciply and Poudingue de la Malogne (Danian) in the Mons Basin and in Danian and Paleocene in almost all regions of U. S. S. R., where sediments of this age are developed. Typical specimens of this species occur in Danian and Selandian of Denmark and Sweden. Present in Thanet beds.

Family PSEUDOPARRELLIDAE VOLOSCHINOVA, 1952 (nom. transl. SUBBOTINA, 1959, ex PSEUDOPARRELLINAE VOLOSCHINOVA, 1952)

Genus **OSANGULARIA** BROTZEN, 1940

Osangularia cordieriana navarroana (CUSHMAN, 1938)

(Plate XIX, figs. 1*a-c*, 5*a-b*)

1938. *Pulvinulinella navarroana* CUSHMAN; J. A. CUSHMAN, Some new species..., p. 66, pl. 11, fig. 5.
1940. *Osangularia lens* BROTZEN; F. BROTZEN, Flintrännans..., p. 30, pl. 27, fig. 1*a-c*.
1945. *Parrella lens* BROTZEN; F. BROTZEN, De geologiska Resultaten..., p. 56, pl. 2, fig. 7*a-c*, text-fig. 10 (1-6).
1948. *Parrella lens* (BROTZEN); F. BROTZEN, The Swedish Paleocene..., p. 104, text-fig. 28 A.
1956*b*. *Osangularia lens* BROTZEN; J. HOFKER, Die Pseudotextularia-Zone..., p. 72, fig. 57.
1957. *Osangularia lens* BROTZEN; J. HOFKER, Foraminiferen..., p. 390, text-fig. 434.
1960. *Osangularia lens* BROTZEN; H. HILTERMANN & W. KOCH, Oberkreide-Biostratigraphie..., p. 72, text-pl. 3.
1961. *Parrella lens* (BROTZEN); V. P. VASILENKO, Foraminifery verchnego mela..., p. 98, pl. 16, fig. 4, 5.
1962. *Osangularia cordieriana navarroana* (CUSHMAN, 1938); E. v. HERMANNI, Zur Artfassung..., p. 280, pl. 19, fig. 2-4.

Material. — Some hundred specimens, well preserved.
Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	0·48	0·82
Shortest diameter of test	0·45	0·73
Height of test	—	0·30

Description. — Test trochiform, biconvex, almost evenly closely coiled, slightly compressed, circular or subcircular in outline, peripheral margin sharply acute, keeled. 3 whorls, more or less, on spiral side. 9-10 chambers in the last formed whorl. Chambers distinct, somewhat triangular on ventral side, trapezoidal on dorsal side, of uniform shape, very moderately increasing in size as added. Sutures distinct, radially extending from the centre up to margin on ventral side, obliquely — on dorsal side. On both sides sutures gently curved, non-depressed. Spiral suture, as well as sometimes the septal sutures, limbate, very slightly raised. Clear umbonal area at the centre, glistening, not raised above the chamber surface. Keel narrow, thin, transparent, even. Wall smooth. Aperture double. A small, short opening at base of last formed chamber on ventral side, near the middle, and a narrow, elongated slit extending obliquely to the suture of the last formed chamber, not connected with it.

Variation. — This species shows rather a big degree of variation which is described in detail in papers of BROTZEN (1940, 1945) and VASILENKO (1961). In Polish material 2 variants have been figured with limbate septal sutures on ventral side (Plate XIX, fig. 1) and with unlimbate, somewhat depressed sutures on ventral side (Plate XIX, fig. 5).

Remarks. — Recently revised by HERMANNI (1962) together with all other species belonging to the genus *Osangularia*. Our specimens differ from the holotype in not having an elongate, but short sutural aperture near the middle. There is a rather striking similarity between *Osangularia cordieriana navarroana* CUSHMAN and *Parrella expansa* TOULMIN (1941), from the Eocene of Alabama, with the same character of double aperture and the same number of chambers.

Distribution. — *Osangularia cordieriana navarroana* is very common in Danian and in Montian in almost all studied samples from Poland. Common in Swedish, Dutch and Danish Danian, also in the Danian of Mangyšlak peninsula (U. S. S. R.). This species appears in the uppermost Maastrichtian, as mentioned by CUSHMAN (1938), BROTZEN (1945) and HOFKER (1956) who observed it already in the *Pseudotextularia* zone in the Netherlands.

Genus **PSEUDOPARRELLA** CUSHMAN & TEN DAM, 1948

Pseudoparrella limburgensis VISSER, 1951

(Plate XVI, figs. 5*a-c*)

1933. *Eponides minimus* CUSHMAN; R. C. VAN BELLEN, Foraminifera..., p. 58, pl. 7, fig. 10-12.
1951. *Pseudoparrella limburgensis* VISSER; A. M. VISSER, Monograph..., p. 278, pl. 7, fig. 10.
1961. *Pseudoparrella limburgensis* VISSER; J. HOFKER, Foraminifera from the Cretaceous..., LIII, p. 67, text-fig. 9,10.

Material. — About 60 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·31
Shortest diameter of test	0·28
Height of test	0·16

Description. — Test lenticular, compressed, outline somewhat lobate. Both sides convex. Peripheral margin acute. On the dorsal side all chambers visible, 5 in the last whorl, with sutures strongly oblique, gently curved. At the ventral side each chamber slightly inflated, the last one lobate, sutures distinct, radial, slightly depressed. Both sides with fine pores. Wall smooth. Aperture wide, open, sutural, loop-shaped on ventral side, between the margin and the centre.

Variation. — Described by HOFKER (1961, 1963).

Remarks. — It is rather difficult to compare with the holotype, described by VISSER (1951), the latter being in a bad state of preservation, rather faintly illustrated. Our specimens have only 5 chambers in the last whorl, instead of 8 in the holotype. Probably they belong to megalospheric form described by VISSER as *Pseudoparrella meeterenae*. Revised by HOFKER (1961, 1963).

Distribution. — Not common in Danian at Bochotnica, Góra Puławska, Sochaczew, Pamiętowo; common in Montian at Bochotnica, Góra Puławska, Żyrzyn, Sochaczew and Pamiętowo. Common in Danian in Denmark and Limburg, as well as in Tuffeau de Ciply (Danian) in Belgium. It seems to disappear in Calcaire de Mons (Montian), above the Tuffeau de Ciply (HOFKER, 1961).

Genus **ALABAMINA** TOULMIN, 1941

Alabamina midwayensis BROTZEN, 1948

(Plate XXI, figs. 3*a-c*)

1948. *Alabamina midwayensis* nov. nom. BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 99, pl. 16, fig. 1, 2 (all synonymy included).
1959. *Alabamina midwayensis* BROTZEN; S. E. NAKKADY, Biostratigraphy..., p. 460, pl. 2, fig. 2.
1960. *Alabamina midwayensis* BROTZEN; J. HOFKER, Foraminifera from the Cretaceous..., XLIX, p. 58, text-fig. 1-6.

Material. — Some hundred specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·38
Shortest diameter of test	0·35
Height of test	0·16

Description. — Test biconvex, lenticular, compressed, dorsal side slightly convex, flattened; ventral side convex, circular in outline, peripheral margin bluntly acute, very faintly lobulate, 3 whorls visible on dorsal side, 5 chambers in last whorl. Chambers triangular on ventral side, trapezoidal on dorsal. Sutures distinct on both sides, nearly flush with surface, only faintly depressed on ventral side, where they are straight, radial and oblique, gently curved on dorsal side. A very small umbilical depression, where sutures meet. Aperture, an elongated, narrow slit at the base of last formed chamber on ventral side. Wall smooth, shining, finely porous.

Variation. — Considerable, discussed by BROTZEN (1948) and HOFKER (1960).

Remarks. — Our specimens do not differ from Swedish ones and the holotype figured by BROTZEN (1948).

Distribution. — Very common in uppermost Maastrichtian, Danian and Montian in all studied localities. Known to be common from Swedish, Danish and Dutch Danian and Paleocene. Abundant at the top of Danian in Egypt.

Family EPISTOMINIDAE BROTZEN, 1942

Genus **HOEGLUNDINA** BROTZEN, 1948

Hoeglundina scalaris (FRANKE, 1927)

(Plate XIX, figs. 2*a-c*)

1927. *Epistomina scalaris* FRANKE; A. FRANKE, Die Foraminiferen und Ostracoden..., p. 39, pl. 4, fig. 6.
1948. *Höglundina scalaris* (FRANKE); F. BROTZEN, The Swedish Paleocene..., p. 94, pl. 15, fig. 2, 3.

Material. — About 50 specimens; most of them damaged.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·50
Shortest diameter of test	0·46
Height of test	0·23

Description. — Test equally biconvex, rounded, circular in outline, closely coiled, peripheral margin strongly angled. Dorsal side consists of 4 whorls, placed on each other stepwise. A kind of big tubercle in the middle. Ventral side strongly elevated, without umbilicus, five chambers in the last whorl, semicrescent, low on dorsal side, triangular on ventral. Sutures distinct, strongly raised, limbate on both sides, septal as well as spiral ones, curved on dorsal side, radially on ventral side. Surface of chambers very restricted by raised spiral and septal sutures; in the centre of dorsal side all raised sutures are so closely interlaced that they form something like a plug or large tubercle. Double peripheral raised margin on ventral side. Latero-marginal apertures and areal apertures in the septae in the inside of test. Wall smooth, except for raised sutures.

Variation. — Not known, due to scarcity and powerty of material.

Remarks. — The affinities with *Epistomina elegans* and a discussion on wall structure was given by BROTZEN (1948).

Distribution. — Rare in Danian and Montian at Góra Puławska and Boryszew. Rare in Swedish Paleocene too. Not known in Montian of Paris Basin (P. MARIE, oral information).

Family CERATOBULIMINIDAE GLAESSNER, 1937

Genus **LAMARCKINA** BERTHELIN, 1881

Lamarckina naheolensis CUSHMAN & TODD, 1942

(Plate XX, figs. 5*a-c*)

1942. *Lamarckina naheolensis* CUSHMAN & TODD; J. A. CUSHMAN & R. TODD, The Foraminifera..., p. 39, pl. 7, fig. 5-7.
1948. *Lamarckina naheolensis* CUSHMAN & TODD; F. BROTZEN, The Swedish Paleocene..., p. 122, pl. 17, fig. 6.
1951. *Lamarckina naheolensis* CUSHMAN & TODD; J. A. CUSHMAN, Paleocene Foraminifera..., p. 49, pl. 14, fig. 4-6.

Material. — 9 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·60
Shortest diameter of test	0·41
Height of test	0·25

Description. — Test plano-convex, compressed, longer than broad, outline lobulate, peripheral margin acute, even slightly keeled, dorsal side flattened or even slightly concave in the centre, ventral side convex, deeply umbilicate. Chambers distinct, 7-8 in number in last whorl, increasing rapidly in size as added. Sutures visible mainly on dorsal side, where they are distinct, limbate, gently curved. Wall distinctly perforated on dorsal side, except sutures. Ventral side quite smooth, polished, glistening. Aperture, an opening into the umbilical cavity, with a large, slightly convex lip extending into and partially covering the umbilicus.

Variation. — Not known, due to scarcity of material.

Remarks. — Our specimens do not differ at all from the holotype described from the Naheola formation (Eocene) in America. This species is an excellent index fossil for the Lower Paleocene.

Distribution. — Very rare in Paleocene at Bochotnica, Sochaczew and Góra Puławska. It occurs in the Paleocene of America, Sweden and Denmark.

Lamarckina rugulosa PLUMMER, 1926

(Plate XXIV, figs. 4*a-c*)

1926. *Lamarckina rugulosa* PLUMMER, MS; J. A. CUSHMAN, The genus *Lamarckina*..., p. 8, pl. 3, fig. 6*a-c*.
1926. *Lamarckina rugulosa* PLUMMER; H. J. PLUMMER, Foraminifera of the Midway..., p. 140, pl. 9, fig. 3*a-c*.
1951. *Lamarckina rugulosa* PLUMMER; J. A. CUSHMAN, Paleocene Foraminifera..., p. 49, pl. 13, fig. 24.
1960. *Lamarckina rugulosa* PLUMMER; R. K. OLSSON, Foraminifera..., p. 37, pl. 6, fig. 5, 6.
1962. *Lamarckina rugulosa* PLUMMER; J. HOFKER, Foraminifera from the Cretaceous..., LXI, p. 129.

Material. — About 30 specimens, well preserved.
Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	0·46	0·50
Shortest diameter of test	0·40	0·40
Height of test	0·30	0·30

Description. — Test very broadly elliptical, to almost round in outline, lobate, moderately compressed. Periphery broadly rounded. Convolutions few, not over $1^1/_2$. Chambers distinct, up to 6 in the last formed whorl, increasing in size rapidly as added. Sutures distinct on dorsal side, limbate, slightly depressed between last chambers, in the early portion somewhat raised, usually covered together with surface of chambers by a coarsely rugose granulation. Ventral side smooth and glistening, sutures slightly depressed, indistinct, umbilicus deeply excavated. Smooth character of ventral surface extends up the dorsal side at the peripheral end, which is seen in the line of coiling on dorsal surface. Aperture, a low, arched opening on the ventral side, sometimes, under a narrow flap, delicately fringed.

Variation. — Only to a very small degree. Mainly in the character of sutures on the dorsal side which can be more raised or less.

Remarks. — Our specimens do not differ from the holotype.

Distribution. — Not very frequent in Montian in almost all studied samples from borings and outcrops. Never to be found in Danian. This species represents an excellent foraminiferal index species of Montian. It occurs in Paleocene of North America, in Montian of Limburg and of Georgia (U. S. S. R.).

Genus **CERATOBULIMINA** TOULA s.s., emend. FINLAY, 1939, and TROELSEN, 1954

Ceratobulimina tuberculata BROTZEN, 1948

(Plate XX, figs. 4*a-b*, 6*a-c*)

1948. *Ceratobulimina tuberculata* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 124, pl. 19, fig. 2, 3.
1956. *Ceratobulimina tuberculata* BROTZEN; J. HAYNES, Certain smaller..., p. 90, pl. 16, fig. 8.
1957. *Ceratobulimina tuberculata* BROTZEN; F. BROTZEN & K. POŻARYSKA, The Paleocene in central Poland. p. 275.
1962. *Ceratobulimina tuberculata* BROTZEN; J. HOFKER, Foraminifera from the Cretaceous..., LXI, p. 129.

Material. — Over two hundred specimens, well preserved.
Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	0·35	0·45
Shortest diameter of test	0·28	0·35
Height of test	0·21	0·29

Description. — Test almost equally biconvex, subglobular, outline circular or subcircular, peripheral margin broadly rounded, slightly lobate. One and a half whorls on dorsal side, 6 chambers visible in last whorl. Chambers inflated on both sides, increasing rapidly in size as added. Sutures distinct, deeply depressed, radial, slightly oblique or even slightly backward curving on dorsal side, radial on ventral side, deeply impressed towards the umbilicus. Umbilicus large, deep. Wall smooth, glossy. Apertural surface large, inflated, aperture umbilical, covered by the dentate margin of the bulging area of last formed chamber.

Variation. — Insignificant; it is a strongly distinctive species.

Remarks. — This species is very close only to *Ceratobulimina perplexa* (PLUMMER). Our specimens differ from the holotype, described from Sweden, by not having any ornamentation in the umbilical depression, like some of Swedish specimens. The discussion and comparison with related species was given in detail by BROTZEN (1948). *Ceratobulimina tuberculata* BROTZEN is an excellent index fossil for the Paleocene. In the Danian all *Ceratobulimina* species are absent. In BROTZEN's opinion (1948), *C. tuberculata* as well as *C. perplexa* are best index fossils for the base of Paleocene.

Distribution. — Common in the Montian in all studied localities, also common in Swedish and Danish Lower Paleocene (Selandian). This species occurs in Montian of Paris Basin (P. MARIE, oral information), in Lower Paleocene of Limburg, in the British Paleocene (Thanet beds) and in southern regions of U. S. S. R.

Genus **COLEITES** PLUMMER, 1934

Coleites reticulosus (PLUMMER, 1926)

(Plate XX, figs. 1*a-c*, 2*a-b*)

1926. *Pulvinulina reticulosa* PLUMMER; H. J. PLUMMER, Foraminifera of the Midway..., p. 152, pl. 12, fig. 5.
1948. *Coleites reticulosus* PLUMMER; F. BROTZEN, The Swedish Paleocene..., p. 109, pl. 18, fig. 1, text-fig. 29-33.
1951. *Coleites reticulosus* (PLUMMER); J. A. CUSHMAN, Paleocene Foraminifera..., p. 54, pl. 15, fig. 1-5.
1953. *Coleites reticulosus* (PLUMMER); E. V. MJATLJUK, Spirillinidy..., p. 122, pl. 28, fig. 7, 8.
1956. *Coleites reticulosus* (PLUMMER); J. HOFKER, Foraminifera from the Cretaceous..., XX, p. 75, text-fig. 1-8.
1960. *Coleites reticulosus* PLUMMER; H. HILTERMANN & W. KOCH, Oberkreide-Biostratigraphie..., p. 73, text-pl. 4.
1961. *Coleites reticulosus* (PLUMMER); V. P. VASILENKO, Foraminifery verchnego mela..., p. 102, pl. 18, fig. 1.
1962. *Coleites reticulosus* PLUMMER; M. E. SCHMID, Die Foraminiferenfauna..., p. 344, pl. 5, fig. 6.

Material. — About 50 specimens, well preserved.
Dimensions of two specimens (in mm.):

	1	*2*
Longest diameter of test	0·40	0·42
Shortest diameter of test	0·33	0·38
Height of test	0·18	0·20

Description. — Test subcircular or broadly elongated, strongly compressed, biconvex, dorsal side more flattened, ventral side strongly convex. Peripheral margin sharply acute and keeled. Chambers rapidly increasing in size as added, 8 in number in coiled portion of last whorl, crescent on ventral side, not visible on the dorsal because both sides are very coarsely reticulate, obscuring all sutures on dorsal side and the last ones on ventral. Sutures slightly depressed between last chambers on ventral side. Aperture, a narrow slit on umbilical side.

Variation. — Considerable; applies to general shape, which can be sometimes more elongated, sometimes less, and also to the degree of reticulation, which can cover almost all surface of ventral side, or only the surface of last two or three chambers.

Remarks. — Our specimens do not differ from the holotype described from Midway formation.

Distribution. — Rare in Montian at Bochotnica, Góra Puławska and at Pamiętowo. Rare in Midway formation and also in Lower Paleocene in Sweden and Denmark. Described by HOFKER (1956, 1959) from Upper Maastrichtian of Limburg who observed »a straight development line from a typical *Pseudoparrella* test with sutural aperture up to a typical *Coleites* form«. Common in Montian of Limburg and a very similar species occurs in Montian of Paris Basin as *Coleites vanbelleni* n. sp. (P. MARIE, oral information). Present in the Crimea. Common in Danian, Paleocene and Lower Eocene in North America, Europe and Africa.

Family ROTALIIDAE REUSS, 1860

Genus **PARAROTALIA** LE CALVEZ, 1949

Pararotalia tuberculifera (REUSS, 1862)

(Plate XX, figs. 3*a-c*)

1862. *Rotalia tuberculifera* REUSS; A. E. REUSS, Die Foraminiferen des norddeuschen Hils und Gault, p. 313, pl. 2, fig. 2.
1957. *Pararotalia tuberculifera* (REUSS); J. HOFKER, Foraminifera from the Cretaceous..., XXIV, p. 32-34, text-pl. 1-18.
1960. *Pararotalia tuberculifera* (REUSS); J. HOFKER, *Ibid.*, L., p. 79, text-pl. 1-8.
1963. *Pararotalia tuberculifera* (REUSS); J. HOFKER, *Ibid.*, LXVI, p. 80, text-pl. 1-6.

Material. — About 40 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·31
Shortest diameter of test	0·27
Height of test	0·14

Description. — Text biconvex, ventral side more convex, dorsal less, outline circular, peripheral margin sharp, ragged. Each chamber of the last formed whorl has sometimes more, sometimes less developed spines at the periphery. Chambers visible only in last formed whorl,

centre of dorsal side covered by numerous tubercles, the centre of ventral side filled by distinct knobs, well separated from chamber walls. Sutures depressed especially in central part of whorl on ventral side, while almost not visible on dorsal side. Aperture at the ventral wall of last formed chamber not entering the umbilicus, more or less loop-shaped. Surface rough throughout all chambers.

Variation. — Described in detail by HOFKER (1957, 1960, 1963).

Remarks. — Our specimens differ from the holotype described by REUSS (1862) from Upper Maastrichtian (Tuffeau) at Maastricht, however do not differ from specimens described and figured in detail by HOFKER (1957) from the same horizon. Very similar to *Discorbis marlierei* MARIE from Calcaire de Mons (P. MARIE, oral information). It was carefully studied, on the one hand by SMOUT (1955) and, on the other, by REISS and MERLING (1958). In another paper (1963) HOFKER described 2 forms of *Pararotalia tuberculifera* (RSS.): one a flat form and the second more robust. The first, having a smaller proloculum, may represent the microspheric generation, while the robust — the megalospheric. The latter is more common.

Distribution. — Very rare in Danian at Pamiętowo only. Not so rare in Montian at Sochaczew and Pamiętowo. According to HOFKER (1957), this very peculiar species begins in the Maastrichtian tuffeau »with very small specimens rapidly increasing in size during *Mb* and *Mc* and decreasing in *Md*«. In higher lying strata (MEIJER's Danian, HOFKER's Paleocene) there occur only »very small specimens which can be aberrant forms of this species«. In another paper from the same year (1957) HOFKER described the first appearance of this species in *Mb* of Limburg as *Globorotalia praetuberculifera*, »since the ventral central knob is totally and always missing«.

Genus **MISSISSIPPINA** HOWE, 1930

Mississippina binckhorsti (REUSS, 1862)

(Plate XVI, figs. 1*a*, *b*)

1861. *Rosalina binkhorsti* REUSS; A. E. REUSS, Paläontologische Beiträge, p. 317, pl. 2, fig. 3*a-c*.
1958. *Mississippina binkhorsti* (REUSS); J. HOFKER, Foraminifera from the Cretaceous..., XXXVI, p. 101, text-fig. 1-6 (earlier synonymy included).
1961. *Discorbis binkhorsti* (REUSS); V. P. VASILENKO, Foraminifery verchnego mela..., p. 37, pl. 7, fig. 5.

Material. — About 20 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·36
Shortest diameter of test	0·28

Description. — Test circular or oval in general outline. The peripheral margin strongly raised, broadly rounded, sides compressed, nearly flat, more convex at the dorsal side, somewhat concave on the ventral, sometimes with an outer peripheral angle, the intervals between as straight lines. Chambers few, up to 5 in last whorl. The last chamber much larger. Sutures limbate, strongly raised, broadly curved. Ornamentation as small tubercles or even faint ribs especially on dorsal side.

Remarks. — Our specimens are not so conical, having more intense ornamentation than the holotype, described by REUSS (1862) from the Upper »Kreidetuff« of Maastricht. The evolution line leading from small, flattened specimens in the Lower *Mb* and even in the *Ma* in Limburg — to often very large and convex specimens in the uppermost Maastrichtian,

was established by HOFKER (1958). In Polish Upper Maastrichtian, Danian and Montian there occur strongly compressed specimens, rather flat on both sides.

Distribution. — In Maastrichtian at Sochaczew and Pamiętowo, in Danian at Góra Puławska, in Montian at Boryszew and Pamiętowo. In the Upper Maastrichtian of Germany, Belgium and the Netherlands. In Danian of Mangyšlak peninsula (U. S. S. R.).

Mississippina midwayensis trinitatensis (CUSHMAN & RENZ, 1942)

(Plate XVII, figs. 2*a-c*)

1942. *Discorbis midwayensis* CUSHMAN var. *trinitatensis* CUSHMAN & RENZ; J. A. CUSHMAN & H. H. RENZ, Eocene, Midway Foraminifera from Soldado Rock, Trinidad, p. 10, pl. 3, fig. 5.

1951. *Discorbis midwayensis* CUSHMAN var. *trinitatensis* CUSHMAN & RENZ; J. A. CUSHMAN, Paleocene Foraminifera..., p. 48, pl. 13, fig. 22.

Material. — About 30 specimens, well preserved.

Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	0·36	0·38
Shortest diameter of test	0·34	0·34
Height of test	0·17	0·18

Description. — Test trochiform, planoconvex, compressed, outline circular, peripheral margin somewhat lobate, acute, with a thickened edge, not sharp, dorsal side convex, ventral side flattened or even slightly concave. Chambers distinct, 5-6 in number in last whorl, slightly inflated, increasing rather rapidly in size as added; sutures distinct, strongly oblique and curved on the dorsal side, limbate and strongly raised, joining with thickened peripheral edge. On ventral side chambers inflated, the last one more inflated, small umbilical depression in the centre, sutures distinct, non-limbate, depressed. Wall smooth, except the raised sutures on dorsal side and the edge, coarsely perforated on both sides (except sutures and edge). Aperture, an elongated opening on the ventral side between the periphery and the umbilicus.

Variation. — Not known because of scarcity of material.

Remarks. — *Discorbis rukazi* HOWE seems to be very close to *Mississippina trinitatensis* CUSHMAN & RENZ. Both are described from America, first from the Eocene of Alabama, second from the Paleocene of Gulf Coastal Region. Our specimens are not so compressed. The dorsal side of Polish specimens is much higher and their edge more raised than the holotype and specimens described by CUSHMAN and RENZ.

Distribution. — Very rare in Montian of Sochaczew and Pamiętowo. Common in Paleocene only in North America.

Family CHILOSTOMELLIDAE BRADY, 1881

Genus **ALLOMORPHINA** REUSS, 1850

Allomorphina hofkeri n. sp.

(Plate XXI, figs. 6*a-b*)

Holotypus: Specimen presented on Pl. XXI, fig. 6*a-b*.

Stratum typicum: Montian.

Locus typicus: Pamiętowo boring, 268 m.

Derivatio nominis: *hofkeri* — in honour of the eminent Dutch micropalaeontologist Dr JAN HOFKER, Sr.

Material. — 60 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Length of test	0·41
Maximum width of test	0·32
Thickness of test	0·18

Description. — Test trochoidal, biconvex, slightly longer than broad, oval, distinctly compressed, periphery broadly rounded, dorsal side somewhat more strongly convex than ventral side. Outline very gently lobular. $2^1/_2$ whorls on dorsal side. Chambers distinct, very slightly inflated, up to 5 in number in last whorl. Chambers rapidly increasing in size as added, the last chamber being very large, somewhat elongated, with a broad, plate-like lip, extending over the umbilicus and covering it entirely. Sutures distinct, radial flush with surface or very slightly depressed. Aperture, a low opening on ventral side, beneath an overhanging plate-like lip. Wall smooth, glistening.

Remarks. — This species is very similar to *Allomorphina allomorphinoides* (REUSS) from the Cretaceous. It differs from the latter only in having a larger lip, developed as a broad plate, not triangular and much larger than in *A. allomorphinoides* (REUSS).

Distribution. — Common in Danian and Montian at Góra Puławska, Żyrzyn and Pamiętowo. HOFKER cited the same species in the Danian and Lower Paleocene of Denmark (HOFKER's manuscript on the Foraminifera from the Maastrichtian, Danian and Montian).

Family GLOBIGERINIDAE CARPENTER, 1862

Genus **GLOBIGERINA** D'ORBIGNY, 1826

Globigerina daubjergensis BRONNIMANN, 1953

(Plate XXIII, figs. 4*a-c*)

1953. *Globigerina daubjergensis* BRONNIMANN; P. BRONNIMANN, Note on planktonic Foraminifera..., p. 340, pl. 1.
1957. *Globigerina daubjergensis* BRONNIMANN; J. C. TROELSEN, Some planktonic Foraminifera..., p. 128, pl. 30, fig. 1-2.
1957. *Globigerinoides daubjergensis* BRONNIMANN; A. R. LOEBLICH *et al.*, Studies in Foraminifera..., p. 184, pl. 40, fig. 1, 8; pl. 41, fig. 9; pl. 42, fig. 6, 7; pl. 43, fig. 1; pl. 44, fig. 7, 8.
1960*a*. *Globigerina daubjergensis* BRONNIMANN; J. HOFKER, Le problème du Dano-Paléocène..., p. 119, pl. 1, fig. 1-9.
1960. *Globigerinoides daubjergensis* BRONNIMANN; M. V. KAČARAVA, Planktonnye foraminifery..., p. 48.
1960. *Globigerinoides daubjergensis* (BRONNIMANN); R. K. OLSSON, Foraminifera..., p. 43, pl. 8, fig. 4-6.
non 1961. *Globigerinoides* sp. cf. *G. daubjergensis* (BRONNIMANN); J. P. H. KAASSCHIETER, Foraminifera of the Eocene..., p. 237, pl. 15, fig. 11.
1962. *Globigerina daubjergensis* BRONNIMANN; W. A. BERGGREN, Some planktonic Foraminifera..., p. 81, text-pl. 11, fig. 1-7; pl. 13, fig. 3-7.

Material. — About 25 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·16
Shortest diameter of test	0·14
Height of test	0·12

Description. — Test very small, trochospiral, high-spired, biconvex, triangular in transverse section, early chambers trochoidal, 3 chambers in last whorl, strongly inflated, nearly

globular, gradually increasing in size, small and shallow umbilicus, sutures deeply depressed, aperture small, subcircular, opening into the umbilicus, wall finely spinose.

Variation. — Rather insignificant. It applies to general size which increases gradually from Danish specimens up to Montian ones, as was shown distinctly by HOFKER (1960).

Remarks. — *Globigerina daubjergensis* is the most important index fossil of the Danian stage, however it occurs also in the lowermost Montian, where it is rare. Our specimens differ from the holotype described from Denmark and from American specimens in having only 3 chambers in last whorl, instead of $3^1/_2$ or 4, in not having secondary sutural apertures in specimens occurring in Danian, and in having a higher, distinctly protruding spire.

Distribution. — Rare in Danian as well as in lowermost Montian at Bochotnica, Góra Puławska and Żyrzyn. Known in almost all regions where the Danian sediments are developed. Common there especially in Upper Danian. Occurring also in lowermost Paleocene.

Globigerina kozlowskii BROTZEN & POŻARYSKA, 1961

(Plate XXIII, figs. 1 *a-c*)

1961. *Globigerina kozlowskii* BROTZEN & POŻARYSKA; F. BROTZEN & K. POŻARYSKA, Foraminifères du Paléocène..., p. 162, pl. 1, fig. 1-14; pl. 2, fig. 1-17; pl. 3.

1962. *Globigerina kozlowskii* BROTZEN & POŻARYSKA; J. HOFKER, Foraminifera from the Cretaceous..., LXI, p. 129, text-fig. on p. 130.

Material. — A hundred or so specimens, well preserved.
Dimensions of 5 specimens (in mm.):

	1	*2*	*3*	*4*	*5*
Longest diameter of test	0·24	0·27	0·27	0·28	0·30
Shortest diameter of test	0·23	0·24	0·21	0·23	0·24
Height of test	0·22	0·15	0·23	0·21	0·21

Description. — Test very small, trochoidal, high spired, closely coiled, composed of $2^1/_2$ or 3 whorls, chambers inflated, $3^1/_2$ in number in last whorl, increasing rapidly in size as added, small proloculum, umbilicus small or missing, aperture single, umbilical, or with several additional sutural small, round openings. Wall finely perforated, coarsely spinose.

Variation. — This species is often as high as broad. Sometimes sutural openings are lacking. Specimens with extremely large proloculum have always additional chambers, one of which overhangs the umbilicus. Additional chambers are smooth, plane, never spinose (BROTZEN & POŻARYSKA, 1961).

Remarks. — Our specimens represent mainly topotypes from the same Pamiętowo boring, from which the holotype has been described. *Globigerina kozlowskii* is closely related to *G. daubjergensis*. The latter dominates in Danian, the last representatives occurring still in lowermost Montian. In the beginning of Montian, the *G. kozlowskii* appears at first rarely, being mixed with the last representatives of *G. daubjergensis*. Later it develops rapidly and is very common already in Middle Paleocene beds. HOFKER (1962) observed that during the Danian and Lower Paleocene in Denmark »high-spirallized forms as *G. daubjergensis* begin to occur together with a decrease of diameter of the proloculum; in *G. kozlowskii* the forms with a high spiral have also smaller proloculum«. Thus HOFKER agrees that *G. kozlowskii* may be the direct offspring of *G. daubjergensis*. HOFKER already, in 1960, presented a series of such forms with additional chambers as well as additional sutural openings. These latter, which have a high spire, belong to *G. kozlowskii*. The similarity and affinities with other species are discussed in a paper by BROTZEN and POŻARYSKA (1961).

Distribution. — Rare in lowermost Paleocene (Montian), very common in Middle Paleocene, rare in uppermost Paleocene. Stated by HOFKER (1962) in Montian in Limburg.

Globigerina pseudobulloides PLUMMER, 1926

(Plate XXIII, figs. 2, 3)

1926. *Globigerina pseudo-bulloides* PLUMMER; H. J. PLUMMER, Foraminifera of the Midway..., p. 133, pl. 8, fig. 9.
1941. *Globigerina pseudo-bulloides* PLUMMER; J. GROVER-MURRAY, Midway microfauna..., p. 740.
1948. *Globigerina pseudobulloides* PLUMMER; D. M. CHALILOV, Stratigrafija..., p. 71, pl. 3, fig. 1.
1953. *Globigerina compressa* PLUMMER var. *pseudobulloides* PLUMMER; N. N. SUBBOTINA, Globigerinidy..., p. 57, pl. 2, fig. 7-14.
1955. *Globigerina pseudobulloides* PLUMMER; J. CUVILLIER et al., Etudes..., p. 534, pl. 1, fig. 1.
1956. *Globigerina pseudobulloides* PLUMMER; J. HAYNES, Certain smaller..., p. 99, pl. 17, fig. 12.
1957. *Globigerina pseudobulloides* PLUMMER; J. A. TROELSEN, Some planktonic Foraminifera..., p. 128, pl. 30, fig. 6-8.
1957. *Globorotalia pseudobulloides* (PLUMMER); A. R. LOEBLICH *et al.*, Studies in Foraminifera, p. 73, pl. 17; fig. 19-21; p. 192, pl. 40, fig. 3, 8; pl. 41, fig. 1; pl. 42, fig. 2; pl. 43, fig. 3; pl. 44, fig. 6; pl. 45, fig. 1; pl. 46, fig. 6.
1957. *Globorotalia pseudobulloides* (PLUMMER); R. A. REYMENT, Notes..., p. 84, pl. 15, fig. 18.
1959. *Globorotalia pseudobulloides* PLUMMER; M. M. MOSKVIN, Atlas..., p. 106, pl. 10, fig. 8.
1960. *Globigerina pseudobulloides* PLUMMER; D. M. CHALILOV, Datskij jarus..., p. 141.
1960. *Globorotalia pseudobulloides* (PLUMMER); R. K. OLSSON, Foraminifera..., p. 46, pl. 9, fig. 19-21.
1960. *Globigerina pseudobulloides* PLUMMER; M. V. KAČARAVA, Planktonnye foraminifery..., p. 36, pl. 1, fig. 4.
1960*a*. *Globigerina pseudobulloides* PLUMMER; J. HOFKER, Le problème du Dano-Paléocène..., p. 120, pl. 2, fig. 1-6.
1960. *Globigerina pseudobulloides* PLUMMER; H. HILTERMANN & W. KOCH, Oberkreide-Biostratigraphie..., p. 73, text-pl. 4.
1962. *Globorotalia (Turborotalia) pseudobulloides* (PLUMMER); W. A. BERGGREN, Some planktonic Foraminifera..., p. 88, text-pl. 12, fig. 1-7, pl. 14, fig. 3.

Material. — About 40 specimens, well preserved.
Dimensions of 3 specimens (in mm.):

	1	*2*	*3*
Largest diameter of test	0·26	0·27	0·36
Shortest diameter of test	0·25	0·22	0·33
Height of test	0·10	0·14	0·23

Description. — Test small, trochospiral, biconvex, spire low, periphery lobulate, broadly rounded, chambers inflated, arranged in $2^1/_2$ whorls, $4^1/_2$ or 5 chambers in the last whorl, increasing rapidly in size as added. Sutures distinct, straight, depressed on both sides, deeper on ventral side. Umbilicus fairly narrow, open. Aperture, a large, crescent opening under a narrow lip and lying more or less centrally, extending from umbilicus towards periphery. Wall distinctly perforated and finely reticulated.

Variation. — Significant, when specimens from different continents are compared. Topotypes from Midway are not strictly the same as specimens from type locality of Danian stage in Denmark (TROELSEN, 1957), differing in several details, as size of umbilicus, character of spire, aperture and so on.

Remarks. — Our specimens have less chambers (10) than the holotype (12) and sutures straight on dorsal side, not so backward curved as in holotype. According to HOFKER (1962), *Globigerina pseudobulloides* PLUMMER has developed from »true *Globigerina (Globigerinella)* and is not related to *Globorotalia*«.

Distribution. — Rare in Danian at Góra Puławska, more common in Montian at Bochotnica, Góra Puławska and Pamiętowo. Very common in Lower Danian in Denmark (TROELSEN, 1957). In Limburg it appears already in uppermost Maastrichtian (*Md*), continuing up to Danian. Stated in Lower Paleocene in Tunis (HOFKER, 1961) and Nigeria (REYMENT, 1957). This species occurs in Danian of many regions of U. S. S. R.

Globigerina (Subbotina) triloculinoides PLUMMER, 1926

(Plate XXII, figs. 2*a-c*)

1926. *Globigerina triloculinoides* PLUMMER; H. J. PLUMMER, Foraminifera of the Midway..., p. 134, pl. 8, fig. 10.
1947. *Globigerina triloculinoides* PLUMMER; N. N. SUBBOTINA, Foraminifery datskich..., p. 102, pl. 5, fig. 29, 30.
1948. *Globigerina triloculinoides* PLUMMER; D. M. CHALILOV, Stratigrafija..., p. 71, pl. 3, fig. 2.
1951. *Globigerina triloculinoides* PLUMMER; J. A. CUSHMAN, Paleocene Foraminifera..., p. 60, pl. 17, fig. 10, 11.
1953. *Globigerina triloculinoides* PLUMMER; N. N. SUBBOTINA, Globigerinidy..., p. 82, pl. 11, fig. 15; pl. 12, fig. 1, 2.
1955. *Globigerina triloculinoides* PLUMMER; J. CUVILLIER et al., Etudes..., p. 534, pl. 1, fig. 2.
1956. *Globigerina triloculinoides* PLUMMER; J. HAYNES, Certain smaller..., p. 99, pl. 17, fig. 11, 15.
1957. *Globigerina triloculinoides* PLUMMER; J. A. TROELSEN, Some planktonic Foraminifera..., p. 129, pl. 30, fig. 4.
1957. *Globigerina triloculinoides* PLUMMER; A. R. LOEBLICH *et al.*, Studies in Foraminifera, p. 183, pl. 15, fig. 18-20; pl. 40, fig. 4; pl. 41, fig. 2; pl. 42, fig. 2; pl. 43, fig. 9; pl. 45, fig. 3; pl. 46, fig. 1; pl. 47, fig. 2.
1959. *Globigerina triloculinoides* PLUMMER; M. M. MOSKVIN, Atlas..., p. 106, pl. 10, fig. 9.
1959. *Globigerina triloculinoides* PLUMMER; S. E. NAKKADY, Biostratigraphy..., p. 461, pl. 3, fig. 5.
1960. *Globigerina triloculinoides* PLUMMER; H. HILTERMANN & W. KOCH, Oberkreide-Biostratigraphie..., p. 73, text-pl. 4.
1960*a*. *Globigerina triloculinoides* PLUMMER; J. HOFKER, Le problème du Dano-Paléocène..., p. 120, pl. 3, fig. 1-4.
1960. *Globigerina triloculinoides* PLUMMER; D. M. CHALILOV, Datskij jarus..., p. 141.
1960. *Globigerina triloculinoides* PLUMMER; M. V. KAČARAVA, Planktonnye foraminifery..., p. 38.
1960. *Globigerina triloculinoides* PLUMMER; R. K. OLSSON, Foraminifera..., p. 43, pl. 7, fig. 22-24.
1961. *Subbotina triloculinoides* (PLUMMER); F. BROTZEN & K. POŻARYSKA, Foraminifères du Paléocène..., p. 160, pl. 4, fig. 4.
1962. *Globigerina (Subbotina) triloculinoides* PLUMMER; M. E. SCHMID, Die Foraminiferenfauna..., p. 346, pl. 6, fig. 3.
1962. *Globigerina triloculinoides* PLUMMER; W. A. BERGGREN, Some planktonic Foraminifera..., p. 86, pl. 14, fig. 1, 2.

Material. — About 30 specimens, well preserved.
Dimensions of 4 specimens (in mm.):

	1	*2*	*3*	*4*
Longest diameter of test	0·27	0·30	0·32	0·32
Shortest diameter of test	0·20	0·26	0·25	0·27
Height of test	0·20	0·19	0·21	0·22

Description. — Test small, coiled spiral, trochoidal, composed of about 2 whorls. $3^1/_2$ chambers in last whorl, the last chambers very rapidly increasing in size as added; strongly inflated, highly globular chambers. Periphery very broadly rounded, distinctly lobular, dorsal side with very low spire, ventral side with a small, shallow, but distinct umbilicus. Aperture, a small, arched slit with lip, extending from the periphery to the umbilical depression. Wall strongly reticulated, rather conspicuously.

Variation. — A highly variable species.

Remarks. — Our specimens do not differ from the holotype described from Midway formation (PLUMMER, 1926). This species has been studied in detail by TROELSEN (1957) from Denmark.

Distribution. — Rare in Danian, only at Góra Puławska. More common in Montian at Bochotnica, Góra Puławska, Pamiętowo and Sochaczew. Rare in the basal Midway beds, common in the upper Midway zone. Common in Danian of Denmark (in Upper Danian), in Austria, Limburg, Egypt, where it appears as early as the Upper Maastrichtian. This species is common in Danian, Paleocene and Lower Eocene of southern regions of U. S. S. R. (CHALILOV, 1948-1960). Rare in Tuffeau de Ciply (Danian), but LOEBLICH and TAPPAN (1957) showed that this species is limited to Paleocene strata (including Danian).

Globigerina trivialis SUBBOTINA, 1953

(Plate XXII, figs. 3*a-c*)

1953. *Globigerina trivialis* SUBBOTINA; N. N. SUBBOTINA, Globigerinidy..., p. 64, pl. 4, fig. 4-6, not fig. 7, 8.
1959. *Globigerina trivialis* SUBBOTINA; M. M. MOSKVIN, Atlas..., p. 106, pl. 10, fig. 10.

Material. — Few specimens, well preserved.
Dimensions of 4 specimens (in mm.):

	1	*2*	*3*	*4*
Longest diameter of test	0·25	0·25	0·26	0·34
Shortest diameter of test	0·22	0·24	0·22	0·24
Height of test	0·16	0·18	0·15	0·19

Description. — Test trochoidal, biconvex, dorsal side convex, broadly rounded, the spire low and broad, composed of about 2 whorls. Chambers strongly inflated, 4 in number in last whorl, rapidly increasing in size, the last very swollen. Sutures distinct, deeply depressed. Umbilicus small. Aperture, very narrow, slit-like opening into the umbilicus. Wall smooth, coarsely perforated.

Variation. — Considerable; according to SUBBOTINA (1953), this species shows a high degree of intraspecific variation. Some specimens have chambers very gradually increasing in size, others — rapidly. Aperture, lying centrally just above the umbilicus, resembles that of *Globigerina bulloides* D'ORBIGNY.

Remarks. — Our specimens differ from the holotype only in having more chambers in spire. They are very close to specimens (figured on pl. IV, fig. 7) which are, according to SUBBOTINA (1953), intermediate forms to tripartite ones, such as *G. triloculinoides* PLUMMER. *G. trivialis* is thus the ancestral species of *G. eocaenica* TERQUEM on the one hand, and on the other of *G. triloculinoides* PLUMMER.

Distribution. — Rare in Danian and Montian at Góra Puławska and Pamiętowo. This species occurs in Maastrichtian and Danian in U. S. S. R.

Globigerina varianta SUBBOTINA, 1953

(Plate XXIII, figs. 5*a-c*)

1953. *Globigerina varianta* SUBBOTINA; N. N. SUBBOTINA, Globigerinidy..., p. 63, pl. 3, fig. 5, 10-12; pl. 4, fig. 1-3; pl. 15, fig. 1-3.
?1957. *Globorotalia varianta* (SUBBOTINA); A. R. LOEBLICH *et al.*, Studies in Foraminifera..., p. 196, pl. 45, fig. 4.
1959. *Globigerina varianta* SUBBOTINA; M. M. MOSKVIN, Atlas..., p. 106, pl. 10, fig. 7.
1960. *Globigerina varianta* SUBBOTINA; M. V. KAČARAVA, Planktonnye foraminifery..., p. 39, pl. 1, fig. 6.
1961. *Globigerina* sp. cf. *G. varianta* SUBBOTINA; J. P. H. KAASSCHIETER, Foraminifera..., p. 236, pl. 15, fig. 9, 10.

Material. — A dozen or so specimens, well preserved.
Dimensions of 3 specimens (in mm.):

	1	*2*	*3*
Longest diameter of test	0·22	0·24	0·29
Shortest diameter of test	0·19	0·21	0·26
Height of test	0·12	0·13	0·19

Description. — Test small, trochospiral, composed of $2^1/_2$ very low whorls. Outline strongly lobulate. Dorsal side nearly flat, ventral convex. Chambers subglobular, inflated, increasing rapidly in size as added, 4 in the last whorl, the last chamber strongly swollen. Sutures distinct, straight, depressed. Small, deep umbilicus. Aperture, an elongated slit under a lip, extending from the umbilicus towards periphery. Wall distinctly perforated, covered with numerous small spines.

Variation. — Considerable; it applies to number of chambers in a whorl, to the development of umbilicus which can be sometimes deep and large, sometimes less so, and to the lip not always developed to the same degree and which is sometimes missing.

Remarks. — Our specimens do not differ from specimens described from northern Caucasus, however they differ from the holotype which has very large, distinct pores. The low spire and number of chambers are the same. American specimens have larger umbilicus and more chambers, 5-6 in the last whorl, instead of 4 as in Russian and Polish ones. This species is most similar to *Globigerina pseudobulloides* PLUMMER. According to BERGGREN (1962), *G. varianta* represents only the stratigraphically younger and morphologically more advanced(?) forms of *G. pseudobulloides*.

Distribution. — Rare in Danian and Montian at Góra Puławska, Pamiętowo and Żyrzyn. Known from many regions of U. S. S. R., from Danian up to Middle Eocene. North American specimens are tentatively included into this species. KAASSCHIETER (1961) described this species, as common, from the Lower Eocene of Belgium.

Globigerina sp.

(Plate XXII, figs. 1*a-c*)

Material. — A dozen or so specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·22
Shortest diameter of test	0·19
Height of test	0·12

Description. — Test small, plano-convex, closely coiled, peripheral margin broadly rounded. Dorsal side flat, ventral convex. Only few chambers in the spire, chambers inflated, rapidly increasing in size as added, 5 in number in last whorl, the last strongly swollen. Sutures depressed. Umbilicus narrow, deep. Aperture, a low arched opening, extending from the umbilicus towards the periphery, bordered by a distinct lip. Wall smooth, very finely perforated.

Remarks. — This species has the character of *Globorotalia* or *Planorotalia*, resembling *G. compressa*, but it has not acute chambers at the base.

Distribution. — In Montian at Pamiętowo.

Family ANOMALINIDAE CUSHMAN, 1927

Genus **ANOMALINA** D'ORBIGNY, 1826

Anomalina burlingtonensis (JENNINGS, 1936)

(Plate XXVI, figs. 3*a-c*, 4*a-c*)

1936. *Cibicides burlingtonensis* JENNINGS; P. H. JENNINGS, A microfauna..., p. 39, pl. 5, fig. 5*a-c*.
1941. *Cibicides burlingtonensis* JENNINGS; L. D. TOULMIN, Eocene smaller Foraminifera..., p. 609, pl. 82, fig. 14, 15.
1948. *Cibicides burlingtonensis* JENNINGS; F. BROTZEN, The Swedish Paleocene..., p. 84, pl. 13, fig. 3.

Material. — Two hundred specimens, well preserved.
Dimensions of 2 specimens (in mm.):

	1 A-form	*2* B-form
Longest diameter of test	0·26	0·44
Shortest diameter of test	0·18	0·37
Height of test	0·10	0·18

Description. — Test small, plano-convex, completely involute on both sides in A-form, compressed, peripheral margin bluntly acute, lobulate, ventral side slightly convex, dorsal — flat or even slightly concave. Chambers 6-7 in number in the last whorl, rapidly increasing in size as added. The last chamber strongly inflated, sutures distinct, depressed, strongly curved. A small, distinct central plug on both sides. Wall distinctly perforated. Aperture, a slit bordered by a narrow lip, extending from the periphery towards dorsal side below the last formed chamber.

Variation. — Insignificant; it applies mainly to the general shape which can be round, or more elongated or less.

Remarks. — Our round specimens do not differ from the holotype described from the Eocene of North America.

Distribution. — Common in Danian and Paleocene at Bochotnica and Góra Puławska. Common in Upper Maastrichtian and Danian of Limburg, and in Danian and Lower Paleocene of Sweden and Denmark. Very common in the Eocene of North America.

Anomalina ekblomi (BROTZEN, 1948)

(Plate XXVII, figs. 6*a-c*)

1948. *Cibicides ekblomi* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 82, pl. 13, fig. 2*a-c*.
1954. *Anomalina (Anomalina) ekblomi* (BROTZEN); V. P. VASILENKO, Anomalinidy, p. 58, pl. 2, fig. 5*a-v*, 6*a-v*, 7*a-b*.
1962. *Gavelinella ekblomi* (BROTZEN); M. E. SCHMID, Die Foraminiferenfauna..., p. 340, pl. 4, fig. 10.

Material. — Over 3 hundred specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·35
Shortest diameter of test	0·27
Height of test	0·14

Description. — Test small, on both sides strongly involute. Peripheral margin rounded, non lobulate. Spiral side convex, ventral side concave or nearly flat. 1.5-2 whorls on spiral side, central part slightly depressed. 9-10 chambers in the last whorl. Sutures strongly curved, transparent, distinct, limbate, slightly depressed between last chambers on spiral side. On ventral side a distinct, narrow, deep umbilicus. A small central plug on dorsal side. Aperture interio-marginal at the base of last chamber extending on ventral side towards the umbilicus, bordered by a narrow lip, with wider lobate lips around the umbilicus, at the base of last 3 chambers. Wall thin, finely perforated, more on ventral side, less on dorsal.

Variation. — Not extensive; the general shape round or more or less oval. Ventral side not often distinctly concave. Umbilicus open or, when lips are well developed, covered.

Remarks. — Our specimens are the same as the holotype figured by BROTZEN (1948) and are similar to those from U. S. S. R. *Anomalina ekblomi* resembles *Cibicides simplex*, differing mainly in having limbate sutures, mostly distinguishable on ventral side, which is commonly concave in *C. ekblomi*. Our tests are more distinctly perforated and sutures never so raised as in *C. simplex*.

Distribution. — Very common in uppermost Maastrichtian, Danian and Paleocene in all studied samples. Common in Lower Paleocene in Sweden and Denmark. Rare in uppermost Maastrichtian of south regions of U. S. S. R., more common in the Danian and Paleocene there.

Anomalina danica (BROTZEN, 1940)

(Plate XXIV, figs. 1*a-c*, 2*a-b*, 3*a-c*)

1927. *Anomalina grosserugosa* GÜMBEL; A. FRANKE, Foraminiferen und Ostracoden..., p. 37, pl. 4, fig. 3.
1940. *Cibicides danica* BROTZEN; F. BROTZEN, Flintrännans..., p. 31, pl. 7, fig. 2.
1944. *Anomalina grosserugosa* GÜMBEL; A. TEN DAM, Die stratigraphische Gliederung..., p. 130, pl. 5, fig. 2*a-c*.
1946. *Anomalina granosa* VAN BELLEN, non HANTKEN; R. C. VAN BELLEN, Foraminifera..., p. 74, pl. 11, fig. 4-6.
1948. *Anomalinoides danica* (BROTZEN); F. BROTZEN, The Swedish Paleocene..., p. 87, pl. 14, fig. 1, text-fig. 22.
1948. *Cibicides simplex* BROTZEN; F. BROTZEN, *Ibid.*, p. 83, pl. 13, fig. 5.
1950. *Anomalina danica* (BROTZEN); V. P. VASILENKO, Foraminifery paleocena..., p. 211, pl. 5, fig. 1.
1954. *Anomalina (Anomalina) danica* (BROTZEN); V. P. VASILENKO, Anomalinidy, p. 67, pl. 4, fig. 3.
1955. *Gavelinella danica* (BROTZEN); J. HOFKER, Foraminifera from the Cretaceous..., III, p. 49, fig. 1*a-g*, fig. 2*a-e*.
1959. *Anomalinoides danicus* (BROTZEN); S. E. NAKKADY, Biostratigraphy..., p. 463, pl. 5, fig. 2.
1960. *Gavelinella danica* (BROTZEN); H. HILTERMANN & W. KOCH, Oberkreide-Biostratigraphie..., p. 75, pl. 4.
1961. *Anomalina (Anomalina) grandis* VASILENKO; V. P. VASILENKO, Foraminifery verchnego mela..., p. 108, pl. 19, fig. 4.
1963. *Anomalina danica* (BROTZEN); O. K. KAPTARENKO-ČERNOUSOVA *et al.*, Atlas..., p. 142, pl. 30, fig. 5.

Material. — Some hundred specimens, well preserved.
Dimensions of 3 specimens (in mm.):

	1	*2*	*3*
Longest diameter of test	0·56	0·55	0·38
Shortest diameter of test	0·45	0·42	0·30
Height of test	0·22	0·25	0·20

Description. — Test very thick, rounded or slightly oval, biconvex, sometimes spiral side flattened, especially in young specimens and in the earlier part of the whorl. Peripheral

margin broadly rounded, sometimes slightly lobulate. Seven chambers in the last whorl, often invisible, the last more inflated. On both sides sutures depressed between last chambers, non visible in the early portion of the last whorl. Umbilicus opened, shallow. Aperture at the base of the last formed chamber, extending to the centre of test along last 3-4 chambers, and bordered by a lip. Wall thick, coarsely distinctly porous on both sides. Wall's surface covered with numerous protuberances, like small, flat, irregular knobs.

Variation. — Intraspecific, considerable; it applies not only to the size and to general shape of test, but also to the degree of development of the surface relief. Wall is sometimes very thick, sutures quite invisible, protuberances strongly developed.

Remarks. — Our specimens differ from the holotype only in having more rounded peripheral margin.

Distribution. — Known from uppermost Maastrichtian, Danian and Paleocene not only from many regions of North Europe, but also from some Mediterranean regions. Very common in uppermost Maastrichtian, Danian and Montian in all studied samples from Poland.

Anomalina praeacuta VASILENKO, 1954

(Plate XXVIII, figs. 2*a-c*)

pars 1937. *Anomalina acuta* PLUMMER; M. F. GLAESSNER, Studien über Foraminiferen..., p. 386, pl. 5, fig. 39.
1948. *Anomalinoides acuta* (PLUMMER); F. BROTZEN, The Swedish Paleocene..., p. 87, pl. 14, fig. 2.
1950. *Anomalina praeacuta* VASILENKO; V. P. VASILENKO, Foraminifery paleocena..., p. 208, pl. 5, fig. 2, 3.
1954. *Anomalina (Pseudovalvulineria) praeacuta* VASILENKO; V. P. VASILENKO, Anomalinidy, p. 111, pl. 16, fig. 1, 2.
1963. *Anomalina (Pseudovalvulineria) praeacuta* VASILENKO; O. K. KAPTARENKO-ČERNOUSOVA *et al.*, Atlas..., p. 143, pl. 30, fig. 4.

Material. — Some hundred specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·44
Shortest diameter of test	0·35
Height of test	0·17

Description. — Test equally biconvex. Peripheral margin subacute, lobulate, $2^1/_2$ whorls visible on dorsal side. Ventral side closely involute, with distinct, central, irregular plug and consists of 12-15 chambers, moderately increasing in size as added. Sutures on ventral side, curved, raised, limbate, thickening near the umbilicus. On dorsal side sutures depressed, curved. A glossy plug in the middle of whorls. Aperture, a peripherical, narrow slit extending along the last chambers on ventral side. Wall finely perforated.

Variation. — Considerable; it applies to general size of specimens, to the development of plugs and to whorls on dorsal side not being always visible. Some specimens have more or less rounded peripheral margin, some acute or subacute.

Remarks. — Our specimens are similar with the holotype described from the Paleocene of Donetz Basin, but differ only in having depressed, and not raised sutures on dorsal side. This species is closely related to *Anomalina acuta* PLUMMER which appears in higher horizons.

Distribution. — Very common in Upper Maastrichtian, Danian and Montian in almost all studied samples. Common in Danian and Paleocene of south regions of U. S. S. R.

Genus **CIBICIDES** MONTFORT, 1808

Cibicides commatus MOROZOVA, 1954

(Plate XXVII, figs. 3*a-c*)

?1945. *Cibicides carrascalensis* COLOM; G. COLOM, Estudio preliminar..., p. 78, pl. 3, fig. 46-52 (*fide* ELLIS & MESSINA, Catal. of Foraminifera).
1954. *Cibicides (Cibicidoides) commatus* MOROZOVA n. sp.; V. P. VASILENKO, Anomalinidy, p. 158, pl. 26, fig. 2.
1956. *Anomalina misrensis* SAID & KENAWY; R. SAID & A. KENAWY, Upper Cretaceous..., p. 153, pl. 6, fig. 22*a-c*.

Material. — Over two hundred specimens, well preserved.
Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	0·47	0·51
Shortest diameter of test	0·39	0·44
Height of test	0·21	0·22

Description. — Test lenticular, coiled involute, nearly equally biconvex, composed of 3 whorls. Chambers numerous, moderately increasing in size as added, in last whorl up to 10-12 in number. Distinct, transparent, glassy plugs on both sides. Sutures distinct, limbate, on spiral side raised in early portion, depressed between last chambers. On spiral side, around central plug, there are ring-like lobs formed by thickening of inner part of sutures. On ventral side sutures transparent, flat, depressed in last chambers. Peripheral margin blunt, angular, keeled. Aperture at the base of last chamber at periphery, extending on spiral side. Test coarsely, distinctly perforated on spiral side.

Variation. — Considerable in size, as well as in general shape. Some specimens are flattened on ventral side, others on spiral side. The central plug on spiral side is generally rough, more or less coarsely sometimes pitted. The thickening of sutures on spiral side is not always distinctly marked.

Remarks. — Some specimens of *Cibicides commatus* are very similar to *C. proprius*, but the sutures of the latter are never raised. The similarity between them is especially visible on ventral side, where *C. proprius* has a well developed central plug. In *C. proprius* the plug on spiral side is smooth, never as coarsely pitted as in *C. commatus*, and without lobs around the central plug. Our specimens are very similar to the holotype described by VASILENKO (1954).

Distribution. — Very common in Upper Maastrichtian, Danian and Paleocene in all samples from all studied localities, except Pamiętowo. Common in uppermost Maastrichtian and Danian of south regions of U. S. S. R. and in Paleocene of Denmark (Kertemindemarl).

Cibicides cf. **cryptomphalus hercegovinensis** DE WITT PUYT, 1941

(Plate XXVI, figs. 1*a-c*)

1941. *Cibicides cryptomphalus* (REUSS) var. *hercegovinensis* DE WITT PUYT; J. F. C. DE WITT PUYT, Geologische und paläontologische Beschreibung... (*fide* ELLIS & MESSINA, Catal. of Foraminifera).
non 1944. *Cibicides cryptomphalus* (REUSS) var. *hercegovinensis* DE WITT PUYT; A. TEN DAM, Die stratigraphische Gliederung..., p. 132, pl. 5, fig. 9.

Material. — About one hundred specimens.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·70
Shortest diameter of test	0·59
Height of test	0·25

Description. — Test large, plano-convex, or even dorsal side slightly concave. Peripheral margin acute, bluntly keeled. Outline slightly oval, non lobulate in the early portion of last whorl, slightly lobulate at the remainder of last whorl. Chambers distinct, 10-11 in number in last whorl, sutures transparent, raised and slightly limbate on both sides, especially near the middle of test. Umbilicus large, filled by a distinct central plug on ventral side, while on dorsal side a small, finely dropped plug is developed. Wall smooth, coarsely perforated on both sides. Aperture, a narrow slit at the base of last formed chamber, extending along the base of about three last chambers on dorsal side.

Variation. — Insignificant; it applies mainly to the general shape and to the size of central dorsal plug, which can be more developed or less.

Remarks. — Our specimens differ from the holotype, described from Eocene of Yugoslavia, in having flattened, not convex, dorsal side and smaller central plug on dorsal side. The specimen figured by TEN DAM seems to belong to *Cibicides succedens* BROTZEN, because it has, as suggested by BROTZEN (1948, p. 81), well developed central plug on both sides and similar general shape of test.

Distribution. — Common in Montian at Bochotnica, Pamiętowo, Sochaczew and Żyrzyn.

Cibicides hemicompressus MOROZOVA, 1954

(Plate XXV, figs. 3*a-c*)

1954. *Cibicides (Gemellides) hemicompressus* MOROZOVA n. sp.; V. P. VASILENKO, Anomalinidy, p. 190, pl. 33, fig. 5.
1960. *Cibicides hemicompressus* MOROZOVA; E. K. ŠUCKAJA, Foraminifery verchnego paleocena..., p. 257, pl. 5, fig. 7 (earlier synonymy included).
1961. *Cibicides hemicompressus* MOROZOVA; G. E. AIZENŠTADT & I. A. PINČUK, Opornye skvažiny..., p. 215.

Material. — 15 specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·53
Shortest diameter of test	0·46
Height of test	0·23

Description. — Test large, equally biconvex, outline round, considerably lobular, peripheral margin subacute, chambers inflated, 7 in number in last whorl. Sutures distinct, depressed, radial on dorsal side, slightly curved on ventral. A large, finely dropped central boss on dorsal side, ventral side depressed in the middle. Wall coarsely perforated on dorsal side. Aperture on the periphery, at the base of last formed chamber, extending on dorsal side along about 4 last chambers and bordered by a narrow lip, penetrating into sutures.

Variation. — Not known, due to scarcity of material.

Remarks. — Our specimens differ from the holotype, described from the Danian of Caucasus, by having more strongly lobulate outline, more compressed test and lacking of a central plug on ventral side. Our specimens are very similar to those described by ŠUCKAJA (1960) from the Upper Paleocene of Crimea, however they differ only in having less chambers in the last whorl (7 instead of 9), and in not having visible inner spiral sutures on dorsal side. The comparison with other species and infraspecific variation was discussed in detail by ŠUCKAJA (1960).

Distribution. — This species occurs in Danian and Montian only at Góra Puławska. Known from the Danian, Paleocene and Lower Eocene of south regions of U. S. S. R.

Cibicides lectus VASILENKO, 1950

(Plate XXV, fig. 2*a-c*)

1950. *Cibicides lectus* VASILENKO; V. P. VASILENKO, Foraminifery paleocena..., p. 218, pl. 6, fig. 2, 3.
pars 1948. *Cibicides succedens* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 80, pl. 12, fig. 1 (non 2).
1954. *Cibicides (Cibicidoides) lectus* VASILENKO; V. P. VASILENKO, Anomalinidy, p. 165, pl. 28, fig. 6, 7.
1963. *Cibicides (Cibicidoides) lectus* VASILENKO; O. K. KAPTARENKO-ČERNOUSOVA, Atlas..., p. 145, pl. 30, fig. 6.

Material. — Over one hundred specimens.
Dimensions of two specimens (in mm.):

	1	*2*
Longest diameter of test	0·57	0·50
Shortest diameter of test	0·50	0·41
Height of test	0·24	0·21

Description. — Test large, involute, plano-convex or biconvex. Peripheral margin acute, non lobulate. Chambers distinct, moderately increasing in size as added, 9-10 in number in last whorl. Sutures strongly curved, very slightly depressed on ventral side, with a small central plug. Sutures on dorsal side raised, joining in the middle, forming the irregular, dropped boss. Aperture, a slit on the periphery, extending towards the dorsal side. Wall coarsely poreous on dorsal side, finely poreous on ventral.

Variation. — Considerable; it applies mainly to size and to degree of development of central boss, which can be large, with irregular cavities and additional apertures around its periphery, or can be small, without additional apertures.

Remarks. — Our specimens do not differ from the holotype described from Montian of Donetz Basin. Specimens figured by BROTZEN (1948, pl. 12, fig. 1), described as *Cibicides succedens*, seems to belong to *C. lectus* VASILENKO, because it has a very small central plug on ventral side and a very characteristic, dropped boss on dorsal side, instead of a smooth, large plug as in *C. succedens*. Septal sutures in specimen figured by BROTZEN on dorsal side are raised and somewhat limbate, thickening into the middle of test, whereas in typical *C. succedens* they are flush with surface.

Distribution. — Common in Montian at Bochotnica, Góra Puławska, Pamiętowo, Sochaczew and Żyrzyn. This species occurs in Montian of Russian Platform, Denmark, Sweden, the Netherlands and Paris Basin (P. MARIE, oral information).

Cibicides mammillatus BROTZEN, 1948

(Plate XXVII, figs. 4*a-c*)

1948. *Cibicides mammillatus* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 81, pl. 10, fig. 15.

Material. — Few specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·30
Shortest diameter of test	0·26
Height of test	0.13

Description. — Test small, biconvex or conoid, compressed, peripheral margin acute or subacute. Ventral side flat, even slightly concave. Dorsal side convex, with more than 3 whorls. Sutures thickened, the last one depressed. A small, transparent, slightly elevated plug covers the inner whorls on dorsal side. A shallow umbilicus, sometimes filled, 9 chambers in the last whorl, on ventral side. Aperture at the base of last chamber, extending towards umbilicus along the last 3 or 4 chambers.

Variation. — Not known, due to scarcity of material.

Remarks. — Our specimens do not differ from the holotype.

Distribution. — Very rare in Montian in Polish material. This species occurs in Lower Paleocene of Sweden and possibly in Montian of Paris Basin (P. MARIE, oral information).

Cibicides ornatus VAN BELLEN, 1946, emend. POŻARYSKA, 1965

(Plate XXV, figs. 1*a-c*)

1946. *Cibicides choctavensis* CUSHMAN & MCGLAMERY var. *ornata* VAN BELLEN; R. C. VAN BELLEN, Foraminifera..., p. 79, pl. 12, fig. 7-9.

Material. — About one hundred specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·39
Shortest diameter of test	0·32
Height of test	0·16

Description. — Test plano-convex, involute on both sides, ventral side strongly convex, distinctly depressed in the middle, dorsal side flat or sometimes slightly concave. Peripheral margin bluntly angulated, with a narrow, broadly rounded keel, very slightly lobulate along last two chambers. Chambers distinct, slightly inflated on ventral side, moderately increasing in size as added, 9-10 in number in last whorl. Sutures gently depressed, strongly curved and limbate on dorsal side, raised near the centre. Wall fairly perforated. Aperture at the periphery, at the base of last formed chamber, extending on dorsal side, penetrating into sutures between last chambers. Aperture bordered by a lip.

Variation. — Considerable; it applies to general size. In large specimens, sutures are not visible on dorsal side, aperture slit strongly developed reaching the centre of test of dorsal side. The adult specimens are coarsely perforated.

Remarks. — Our specimens do not differ from the holotype described by VAN BELLEN (1946), but it seems that they differ strongly from *Cibicides choctavensis* described by CUSHMAN and MCGLAMERY (1938), therefore it would be justified to erect new species *C. ornata* VAN

BELLEN. *C. choctavensis* CUSHMAN & MC. GLAMERY has more chambers in the last whorl ($10^1/_2$) and visible inner coils on dorsal side.

Distribution. — Common in Danian, but only at Pamiętowo and in Montian at Pamiętowo, Góra Puławska and Sochaczew. Known from Montian at Limburg region and probably in Montian of Paris Basin (P. MARIE, oral information).

Cibicides proprius (BROTZEN, 1948)

(Plate XXVII, figs. 1*a-c*, 5*a-c*)

1948. *Cibicidoides proprius* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 78, pl. 12, fig. 3, 4.
?1948. *Cibicides* ex gr. *spiropunctatus* GALL. & MORR.; D. M. CHALILOV, Stratigrafija..., p. 87, pl. 6, fig. 5.
1954. *Cibicides (Cibicidoides) proprius* BROTZEN; V. P. VASILENKO, Anomalinidy, p. 168, pl. 29, fig. 1, 2.
1957. *Cibicides (Cibicidoides) proprius* BROTZEN; A. WOOD & J. HAYNES, Certain smaller..., p. 46, pl. 5, fig. 1, 2.
1960. *Cibicides proprius* BROTZEN; E. K. ŠUCKAJA, Foraminifery verchnego paleocena..., p. 255, pl. 5, fig. 3-5.

Material. — About hundred specimens, well preserved.
Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	0·34	0·44
Shortest diameter of test	0·30	0·35
Height of test	0·17	0·14

Description. — One of the largest species of *Cibicides* known in Polish material. Test biconvex, the ventral side more convex than the dorsal. Peripheral margin broadly rounded or bluntly acute, slightly lobulate. 8-9 chambers in the last whorl. On dorsal side distinct, dropped central plug. Ventral side bears a small transparent plug. $2^1/_2$ whorls often not visible. Sutures curved, depressed between last chambers on both sides, remaining raised on dorsal side. Test distinctly perforated on dorsal side. Aperture on peripheral margin, extending on ventral side along 3-4 last chambers.

Variation. — Considerable; it applies to general size of specimens as well as to the size of central plugs.

Remarks. — Our specimens do not differ from the holotype figured by BROTZEN (1948). *Cibicides proprius* is very similar to *C. spiropunctatus* GALLOWAY & MORREY, described from late Cretaceous of Mexico, and seems to be closely related with it. The latter is less lobulate, has not depressed sutures and a larger, more prominent ventral plug (see BERMUDEZ, 1949).

Distribution. — Common in Danian and Montian at Bochotnica, Boryszew, Góra Puławska, Pamiętowo and Sochaczew. Known from Swedish, Danish and Dutch Danian and Paleocene, from Danian and Paleocene of south regions of U. S. S. R., from Montian of Paris Basin (P. MARIE, oral information) and Thanet beds (England).

Cibicides sahlstroemi BROTZEN, 1948

(Plate XXVII, figs. 2*a-c*)

1948. *Cibicides sahlströmi* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 85, pl. 17, fig. 1.

Material. — Some hundred specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·18
Shortest diameter of test	0·16
Height of test	0·06

Description. — The smallest known species of *Cibicides*, less than 0.2 mm. in diameter. Dorsal side convex, ventral, flat or even slightly concave. $2^1/_2$ whorls, up to 3, visible on dorsal side. 10-11 chambers in last whorl. Peripheral margin more or less acute, slightly lobulate, especially in the last chambers. Sutures slightly curved, distinctly raised on dorsal side, the spiral suture as well as the septal, sutures between last chambers depressed on both sides. Umbilical plug distinct and large. Aperture, very narrow slit at the base of last 3 chambers, extending on dorsal side. Wall finely perforated on both sides.

Variation. — Not considerable; this applies mostly to ornamentation which obscures the proper plan of test.

Remarks. — Our specimens are more flattened than the holotype, described from Swedish Paleocene (BROTZEN, 1948), being much more similar to topotypes from Klagshamn.

Distribution. — This species was known up to now only from Paleocene of Sweden. Common in uppermost Maastrichtian, Danian and Montian in almost all studied borings and outcrops in Poland.

Cibicides simplex BROTZEN, 1948

(Plate XXVI, figs. 2*a-c*)

1948. *Cibicides (Cibicidoides) simplex* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 83, pl. 13, fig. 4, non fig. 5*a-c*.

?1960. *Anomalina simplex* (BROTZEN); E. K. ŠUCKAJA, Foraminifery verchnego paleocena..., p. 250, pl. 3, fig. 1, 2.

1960. *Cibicides simplex* BROTZEN; R. K. OLSSON, Foraminifera..., p. 53, pl. 12, fig. 7-9.

Material. — Some hundred specimens, well preserved.

Dimensions of an average specimen (in mm.):

Longest diameter of test	0·70
Shortest diameter of test	0·60
Height of test	0·25

Description. — Test plano-convex. Dorsal side flat or even slightly convex. Ventral side moderately convex. Coiled involute, the inner whorls not visible. 10-11 chambers in the last whorl. Sutures very strongly curved, limbate and raised on both sides, especially on dorsal side. Sutures slightly depressed between last chambers on ventral side. Peripheral margin angular. Aperture arched at the base of last chamber, extending on dorsal side, bordered sometimes by a narrow lip. Wall coarsely perforated on dorsal side.

Variation. — Insignificant. A highly distinctive species.

Remarks. — Our specimens are very similar to the holotype, described from the Swedish Paleocene (BROTZEN, 1948) and to topotypes from Klagshamn. The similarity of *C. simplex* with *Anomalina ekblomi* (BROTZEN) and another species was described in detail by BROTZEN (1948, p. 83). In our opinion *C. simplex* is close to *C. mammillatus* BROTZEN, in which the ventral side possesses a central transparent plug, covering inner whorls.

Distribution. — Common in Upper Cretaceous and Danian. Not so common in Montian. Known from Sweden and North America, possibly from Montian of Paris Basin (P. MARIE, oral information) and Upper Paleocene of the Crimea (ŠUCKAJA, 1960).

Cibicides succedens BROTZEN, 1948

(Plate XXVIII, figs. 1, 5)

1944. *Cibicides cryptomphalus* (REUSS) var. *hercegovinensis* DE WITT PUYT; A. TEN DAM, Die stratigraphische Gliederung..., p. 132, pl. 5, fig. 9.
1948. *Cibicides succedens* BROTZEN; F. BROTZEN, The Swedish Paleocene..., p. 80, fig. 2. pl. 12, not fig. 1.
1953. *Cibicides succedens* BROTZEN; N. K. BYKOVA, Foraminifery..., p. 94, pl. 5, fig. 2, not fig. 1.
1954. *Cibicides (Cibicidoides) succedens* BROTZEN; V. P. VASILENKO, Anomalinidy, p. 159, pl. 27, fig. 5, 6.
1957. *Cibicides (Cibicidina) succedens* BROTZEN; A. WOOD & J. HAYNES, Certain smaller..., p. 50, pl. 5, fig. 6, 7.
1960. *Cibicides (Cibicidina) succedens* BROTZEN; A. ROUVILLOIS, Le Thanétien du Bassin de Paris, p. 76, pl. 4, fig. 59.
1960. *Cibicides succedens* BROTZEN; R. K. OLSSON, Foraminifera..., p. 53, pl. 12, fig. 10-12.
1963. *Gavelinopsis succedens* (BROTZEN); J. HOFKER, Foraminifera from the Cretaceous..., LXIII, p. 7, text-fig. 5.

Material. — Some hundred specimens, well preserved.
Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	0·50	0·50
Shortest diameter of test	0·47	0·40
Height of test	0·30	0·25

Description. — Test strongly convex on ventral side, flattened or slightly convex on the dorsal. Distinct, large, transparent plugs on both sides, covering inner whorls. The plug strongly elevated on dorsal side. Peripheral margin acute, sometimes bluntly keeled. 9-10 chambers in the last whorl. Sutures distinct, not raised, slightly depressed, strongly curved, transparent. Aperture peripheral, extending along 3 chambers on dorsal side. Wall smooth, glossy, finely perforated on dorsal side, more distinctly on ventral side.

Variation. — Applies mainly to general shape which can be plano-convex, or more or less biconvex. The plug sometimes is very small (in specimens not very high), sometimes very large (in high specimens).

Remarks. — *Cibicides succedens* BROTZEN is, on the one hand, very similar to *C. lectus* VASILENKO (see *C. lectus*, p. 132), and on the other, to *C. voltziana* (D'ORB.). The young specimens of *C. voltziana* (D'ORB.) are very similar to *C. succedens*, especially to the plano-convex specimens of the latter. Adult specimens differ from *C. succedens* in general shape, being always biconvex, generally bigger and lacking a plug on ventral side.

Distribution. — *Cibicides succedens* is very common in Montian in Europe, as well as in America. According to BROTZEN's paper (1948), it is closely related to *C. voltziana* from the Maastrichtian and Danian.

Cibicides voltzianus (D'ORBIGNY, 1840)

(Plate XXVIII, figs. 4*a-c*)

1840. *Rotalina (Rotalina) voltziana* D'ORBIGNY; A. D'ORBIGNY, Mémoire sur les Foraminifères..., p. 31, pl. 2, fig. 32-34.
1937. *Planulina voltziana* (D'ORBIGNY, 1840); N. A. KALININ, Foraminifera..., p. 56, pl. 8, fig. 118-120.
?1940. *Cibicides voltziana* D'ORBIGNY; F. BROTZEN, Flinträннans..., p. 24, text-pl. 7, fig. 3.
1941. *Cibicides Voltziana* D'ORBIGNY, var. *denticulata* MARIE; P. MARIE, Les Foraminifères..., p. 248, pl. 37, fig. 348-349.
?1953. *Cibicides libycus* LE ROY; L. W. LE ROY, Biostratigraphy..., p. 24, pl. 5, fig. 1-3.

1954. *Cibicides (Cibicidoides) voltzianus* (ORBIGNY) emend. MARIE; V. P. VASILENKO, Anomalinidy, p. 154, pl. 25, fig. 3, 4.
1956*a*. *Gavelinopsis voltziana* (D'ORBIGNY); J. HOFKER, Les Foraminifères..., p. 197, fig. 45 (on p. 221).
1957. *Gavelinopsis voltziana* (D'ORBIGNY); J. HOFKER, Foraminiferen..., p. 336, text-fig. 387, 388.
1961. *Gavelinopsis voltziana* (D'ORBIGNY); J. HOFKER, Die Foraminiferen-Fauna der Gruben Hemmoor und Basbeck, p. 141, text-fig. 10.
1961. *Cibicides (Cibicidoides) voltzianus* (ORBIGNY) emend. MARIE; V. S. AKIMEC, Stratigrafija i foraminifery..., p. 171, pl. 17, fig. 4, 5.
1963. *Cibicides (Cibicidoides) voltzianus* (ORBIGNY); O. K. KAPTARENKO-ČERNOUSOVA *et al.*, Atlas..., p. 99, pl. 24, fig. 1.

Material. — About hundred specimens, well preserved.
Dimensions of an average specimen (in mm.):

Longest diameter of test	0·50
Shortest diameter of test	0·40
Height of test	0·20

Description. — Test large, biconvex, compressed, peripheral margin acute, bluntly keeled, lobulate, chambers slightly inflated, gradually increasing in size as added, 9 in number in last whorl. Sutures distinct, limbate, depressed only between last chambers, being somewhat sickled. Distinct, glossy umbilical plug on ventral side, more prominent than central, dropped plug on dorsal side. Wall coarsely perforated on dorsal side, finely perforated on ventral. Aperture on the periphery extending along two last chambers on dorsal side, bordered by an unporeous, distinct lip.

Variation. — Considerable; it applies to general shape and size and to the degree of development of plugs.

Remarks. — This species is similar, on the one hand, to *Cibicides spiropunctatus* GALLOWAY & MORREY from Upper Cretaceous, and on the other hand, to *C. proprius* BROTZEN from Danian and Montian. It differs in having more compressed test, less acute and having lobulate peripheral margin and more inflated chambers. In comparison with the holotype, our specimens have a more blunted periphery, less visible or quite obscured and invisible inner coils on dorsal side, and more curved sutures on ventral. The last chamber in holotype is more strongly inflated. BROTZEN (1948) suggests that *Cibicides succedens* from Paleocene is closely related to *C. voltzianus* (D'ORBIGNY). HOFKER supposes that *C. voltzianus* is restricted rather up to Maastrichtian, while in Danian *Gavelinopsis involuta* (REUSS) is developed.

Distribution. — This species occurs commonly in Upper Maastrichtian in all studied borings and quarries, rarely in Danian at Bochotnica, Sochaczew and Żyrzyn. Known in Upper Cretaceous mainly from Upper Campanian — Maastrichtian of Paris Basin, Belgium, the Netherlands, Germany, Sweden, North America and south regions of U. S. S. R.

Cibicides sp.

(Plate XXVIII, figs. 3*a-c*)

Material. — About 30 specimens; the last chamber often damaged.
Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	0·28	0·25
Shortest diameter of test	0·24	0·22
Height of test	0·10	0·09

Description. — Test small, plano-convex, slightly lobulate in outline, especially at the end of the last whorl. Peripheral margin angular. Dorsal side bears small umbonal plug, surrounded — as a rule — by a narrow slit, penetrating between chamber margins and forming a star-like pattern. Ventral side with the central portion slightly depressed and sometimes with small plug. Chambers distinct, 10-12 in number in the adult whorl, increasing gradually in size as added. Sutures distinct, slightly depressed, almost radial on ventral side, but raised, thickened near central part of test at the beginning, curved on dorsal side. Wall smooth ventrally, but finely perforated dorsally. Aperture at the base of last formed chamber, at the periphery, with a very slight lip, extending over into the dorsal side.

Variation. — Not considerable; it applies to general size and the development of the star-like pattern in central part of dorsal side.

Remarks. — This highly distinctive species is not similar to any known *Cibicides* species. It seems to be a new species.

Distribution. — Rare in Danian at Pamiętowo, and in Montian at Góra Puławska, Pamiętowo and Sochaczew.

Genus **KARRERIA** RZEHAK, 1891

Karreria fallax RZEHAK, 1891

(Plate XIX, figs. 3, 4)

1891. *Karreria fallax* RZEHAK; A. RZEHAK, Die Foraminiferenfauna..., p. 4, pl. 7, fig. 7*a-c*, 8*a-b*.
1927. *Karreria fallax* RZEHAK; A. FRANKE, Die Foraminiferen und Ostrakoden..., p. 40, pl. 4, fig. 7*a-b*.
1948. *Karreria fallax* RZEHAK; F. BROTZEN, The Swedish Paleocene..., p. 114, pl. 18, fig. 3, text-fig. 34, 35 (1-14), 36, 37.
1957. *Karreria fallax* RZEHAK; J. HOFKER, Foraminifera from the Cretaceous..., XXVII, p. 98, fig. 1, 2.
1961. *Karreria fallax* RZEHAK; V. P. VASILENKO, Foraminifery verchnego mela..., p. 144, pl. 29, fig. 5; pl. 30, fig. 1-4; pl. 31, fig. 1, 2.
1962. *Karreria fallax* RZEHAK; M. E. SCHMID, Die Foraminiferenfauna..., p. 345, pl. 5, fig. 5.

Material. — Some hundred specimens, well preserved.
Dimensions of 2 specimens (in mm.):

	1	*2*
Longest diameter of test	0·48	0·70
Shortest diameter of test	0·40	0·65
Height of test	0·30	0·40

Description. — Test rounded or elongated, plano-convex, evolute on dorsal side which can be flat or concave, involute on ventral side which is strongly convex. Peripheral margin rounded, outline distinctly lobate. Chambers distinct, inflated, triangular in general shape, except the last one which is more strongly swollen, six in number on dorsal side, five on ventral. In the adult often arranged rectilinearly. Sutures distinct, radiating from the centre, deeply depressed, curved on ventral side. Umbilical depression rather small or often absent. Wall smooth, thick. Aperture, round or elongated area, rather large, at the base of the last formed chamber. Sometimes two or more openings situated near the periphery.

Variation. — Considerable, applies mainly to general shape of test, coiled or rectilinear, and to chambers. Intraspecific variation was discussed in detail and figured by BROTZEN (1948), HOFKER (1957) and VASILENKO (1961).

Remarks. — The affinities between *Karreria fallax* and *Cibicides beaumontianus* were discussed by the three above mentioned authors. Our specimens do not differ from the holotype, described by RZEHAK from the Danian of Austria (BROTZEN, 1948, p. 114), earlier described as Lower Tertiary (RZEHAK, 1891).

Distribution. — Very common in Danian and in Montian at Bochotnica, Boryszew, Góra Puławska, Nasiłów, Pamiętowo, Sochaczew and Żyrzyn. Common in Danian and Montian in other countries.

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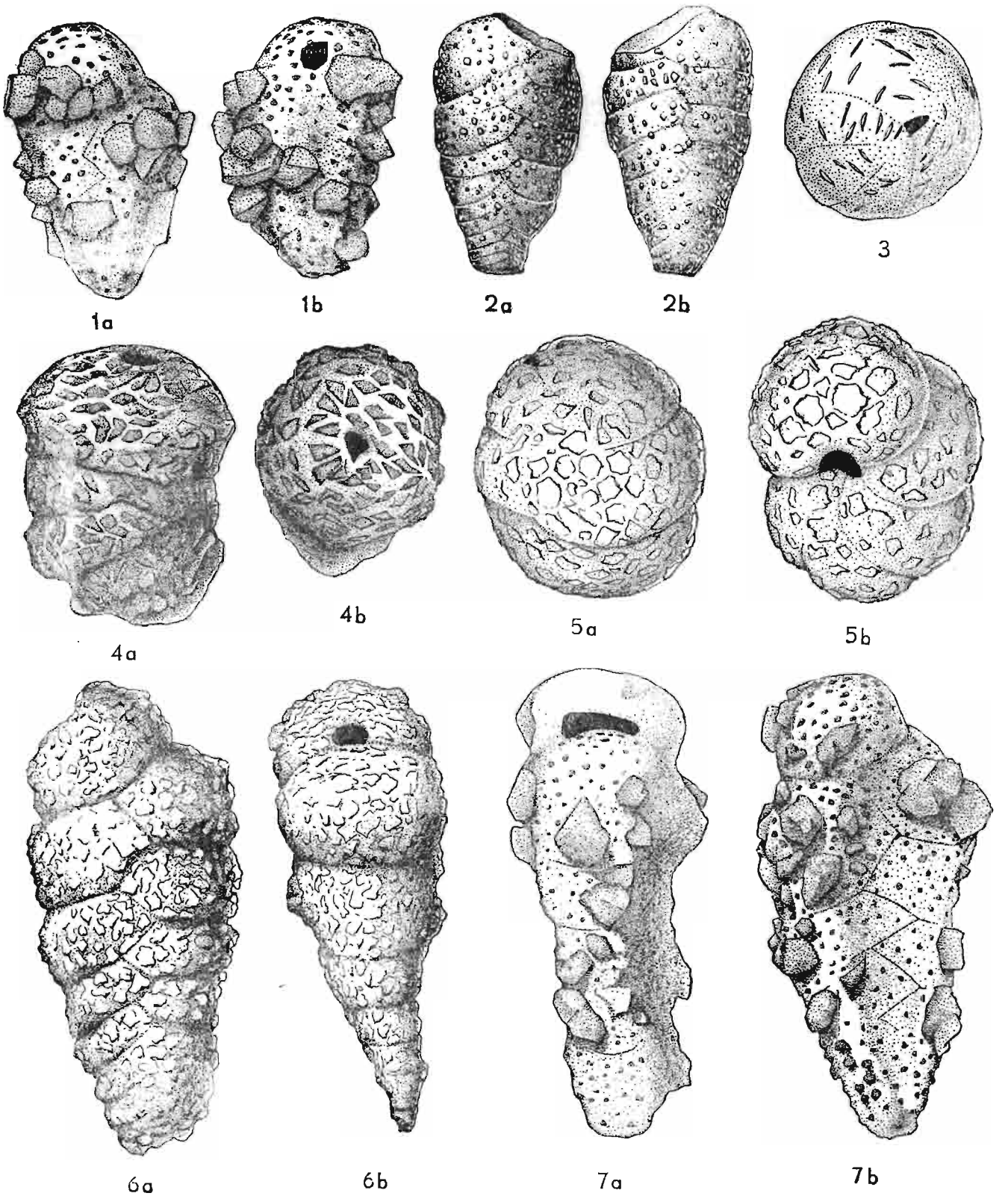

K. Budzyńska, del.

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Fig. 4. *Arenobulimina mohreni* BROTZEN (F. VI/9), Bochotnica quarry, Montian; × 33 57

Fig. 5. *Spiroplectammina baudouiniana* (D'ORBIGNY) (F. VI/10), Sochaczew boring, 271 m., Upper Maastrichtian; × 85. 48

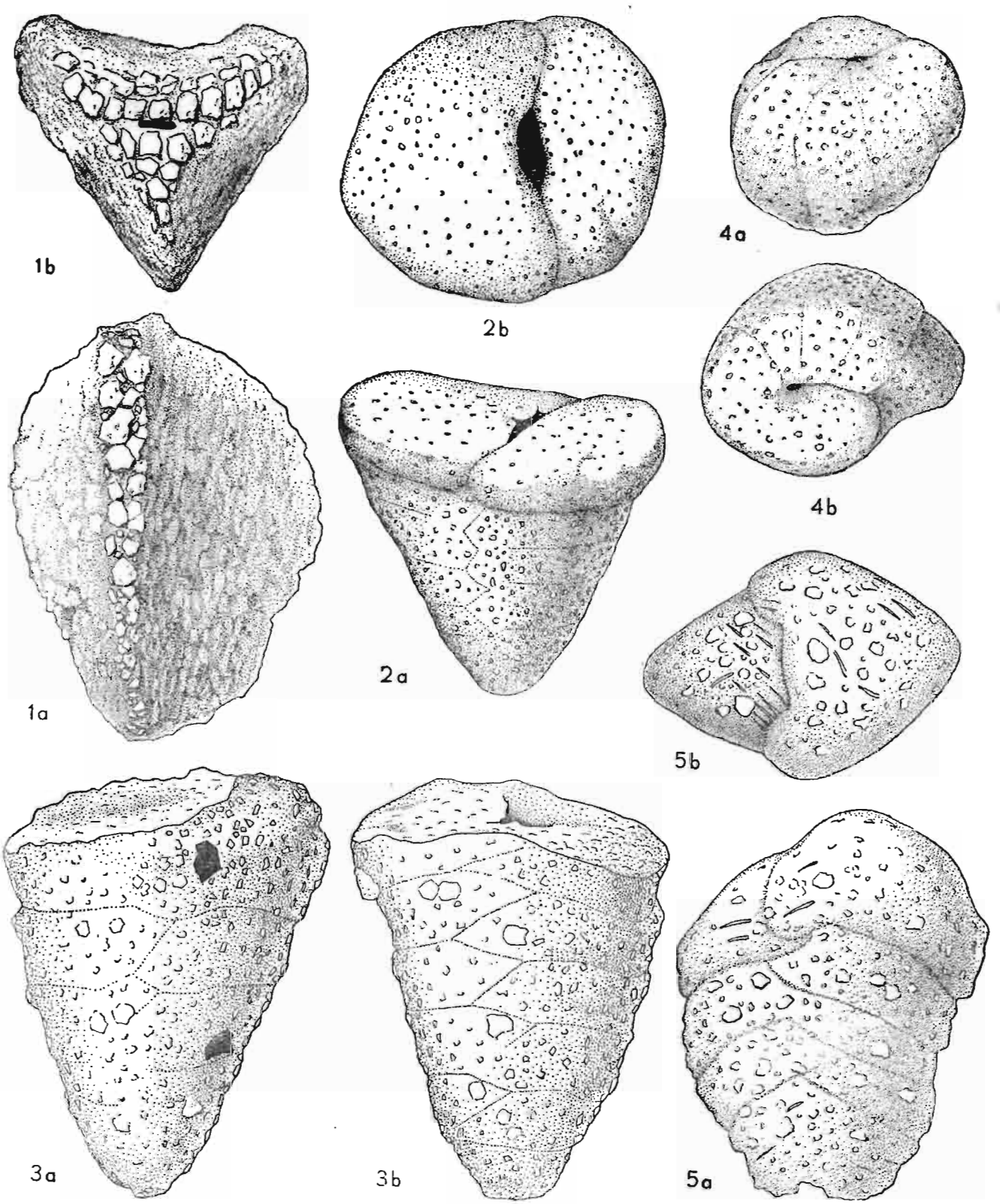

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Fig. 1. *Spiroplectammina wilcoxensis* CUSHMAN & PONTON (F. VI/11), Pamiętowo boring, 257 m., Montian; × 140 50

Figs. 2—5. *Orbignyna ovata* HAGENOW (F. VI/12) 59

Fig. 2. Boryszew boring, 202·9 m., Montian; × 33.

Fig. 3. Same; × 60.

Fig. 4. Same; × 33.

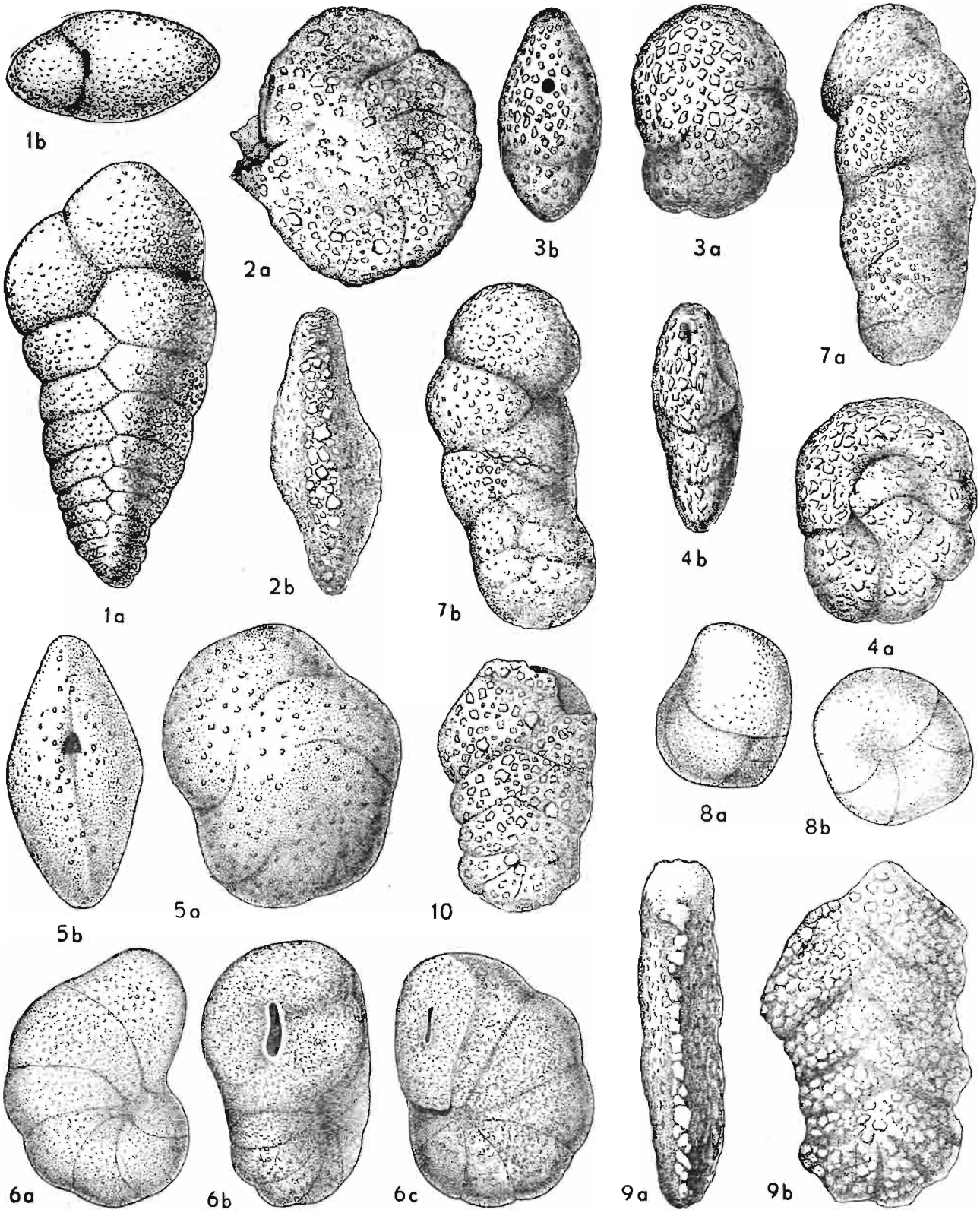
Fig. 5. Bochotnica quarry, Danian; × 60.

Fig. 6. *Orbignyna inflata* (REUSS) (F. VI/13), Sochaczew boring, 265 m., uppermost Maastrichtian; × 30 . . 58

Fig. 7. *Plectina*? *convergens* (KELLER) (F. VI/14), Bochotnica quarry, Montian; × 60 60

Fig. 8. *Arenobulimina* sp. (F. VI/15), Sochaczew boring, 216·7 m., Montian; × 80. 58

Figs. 9, 10. *Spiroplectammina suturalis* (KALININ) (F. VI/16), Bochotnica quarry, Montian; × 60. 49



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Figs. 1, 6. *Gaudryina* cf. *bulloides* OLSSON (F. VI/17), Boryszew boring, 202·9 m., Montian; fig. 1; × 65, fig, 6; × 63 53

Figs. 2, 3. *Gaudryina (Textularia) faujasi* (REUSS) (F. VI/18), Boryszew boring, 202·9 m., Montian; × 33 . . . 52

Fig. 4. *Verneuilina monmouthensis* OLSSON (F. VI/19), Boryszew boring, 202·9 m., Montian; × 63 51

Fig. 5. *Beisselina aequisgranensis* (BEISSEL) (F. VI/20), Bochotnica quarry, Montian (probably derived); × 30 60

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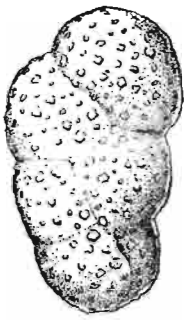
Fig. 8. *Arenobulimina cuskleyae* JENNINGS (F. VI/22), Boryszew boring, 202·9 m., Montian; × 90 56

Fig. 9. *Clavulina parisiensis* D'ORBIGNY (F. VI/23), Góra Puławska boring, 12·5 m., Montian; × 66 54



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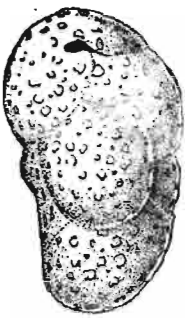

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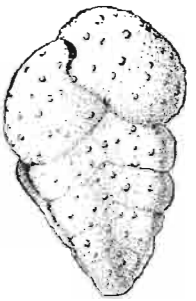

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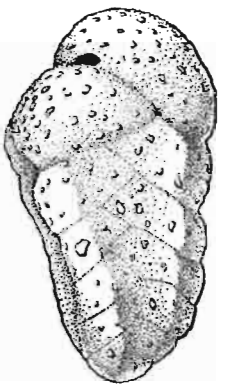

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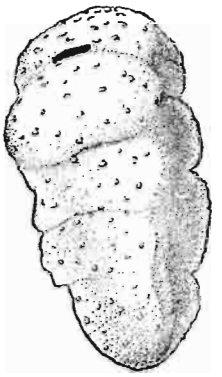

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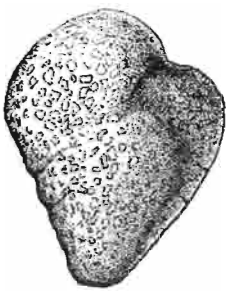

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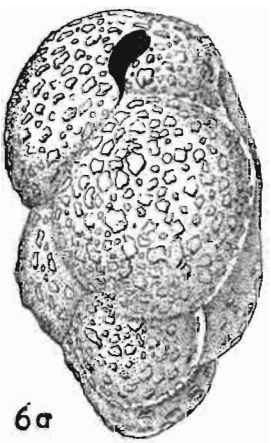

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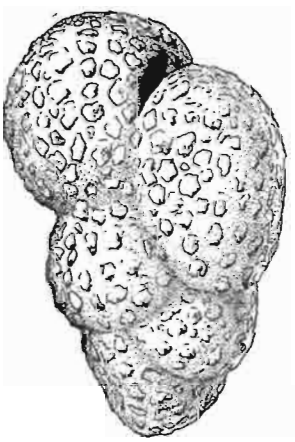

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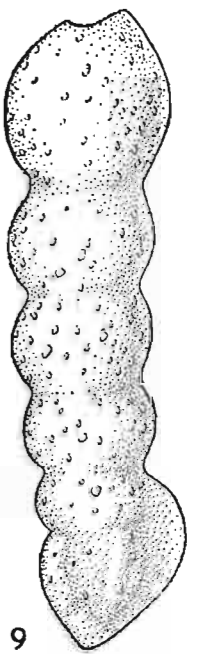

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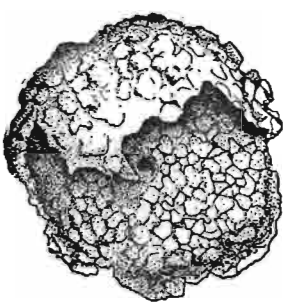

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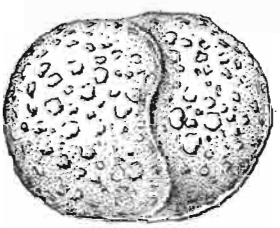

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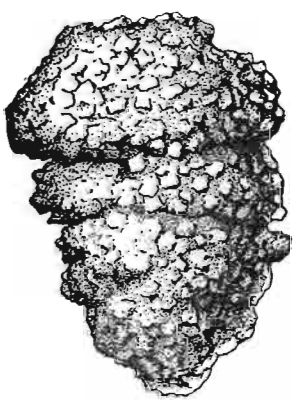

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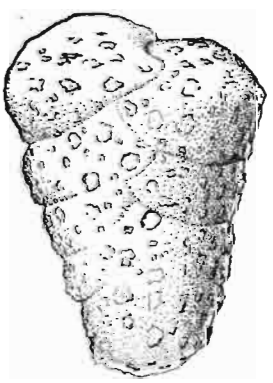

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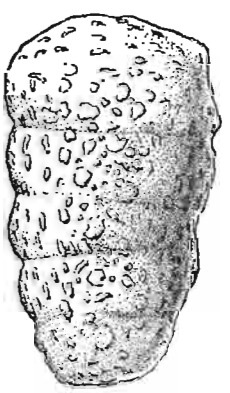

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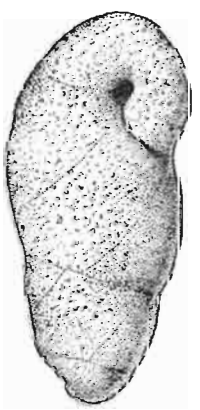

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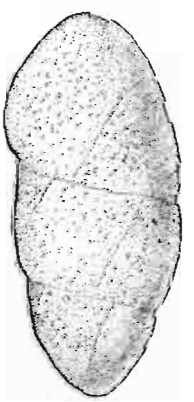

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Fig. 1. *Palmula robusta* BROTZEN (F. VI/24), Nasiłów quarry, Montian; × 12 80
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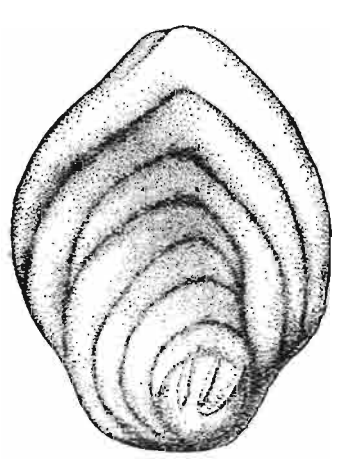

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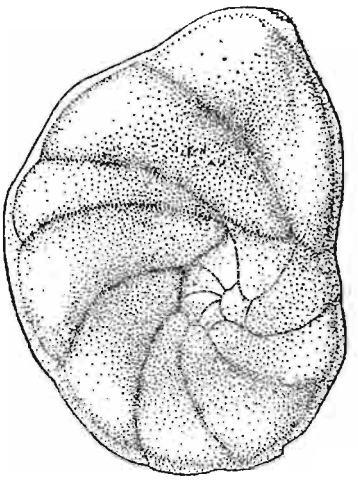

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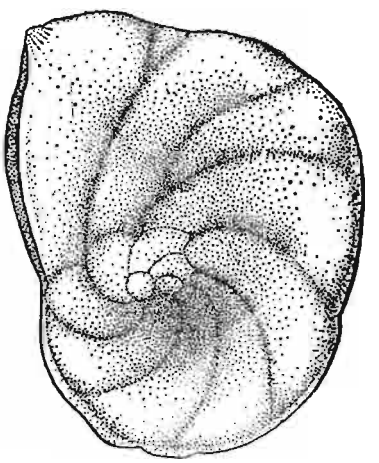

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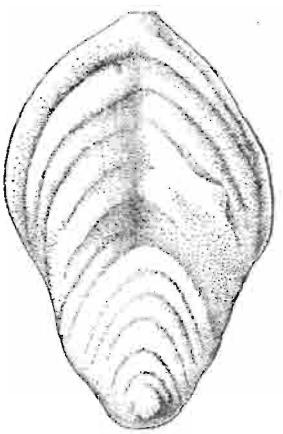

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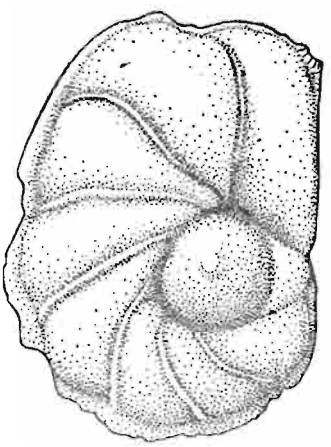

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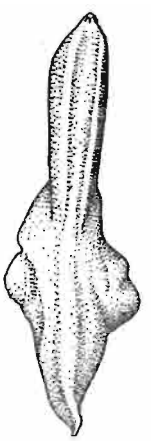

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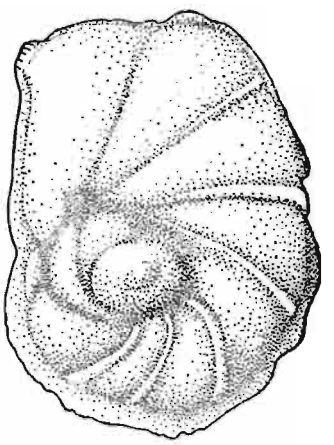

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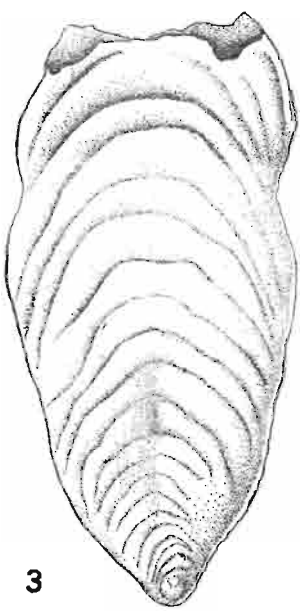

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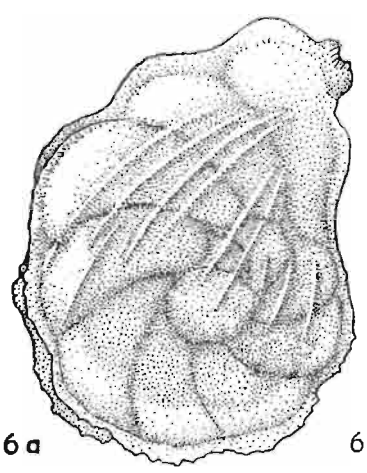

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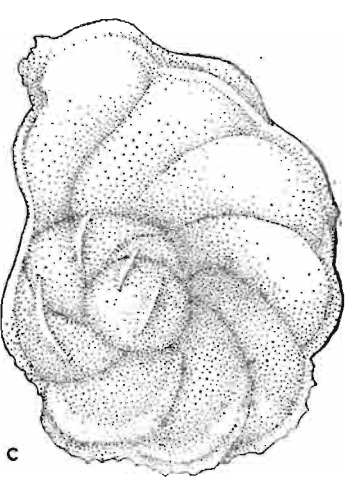

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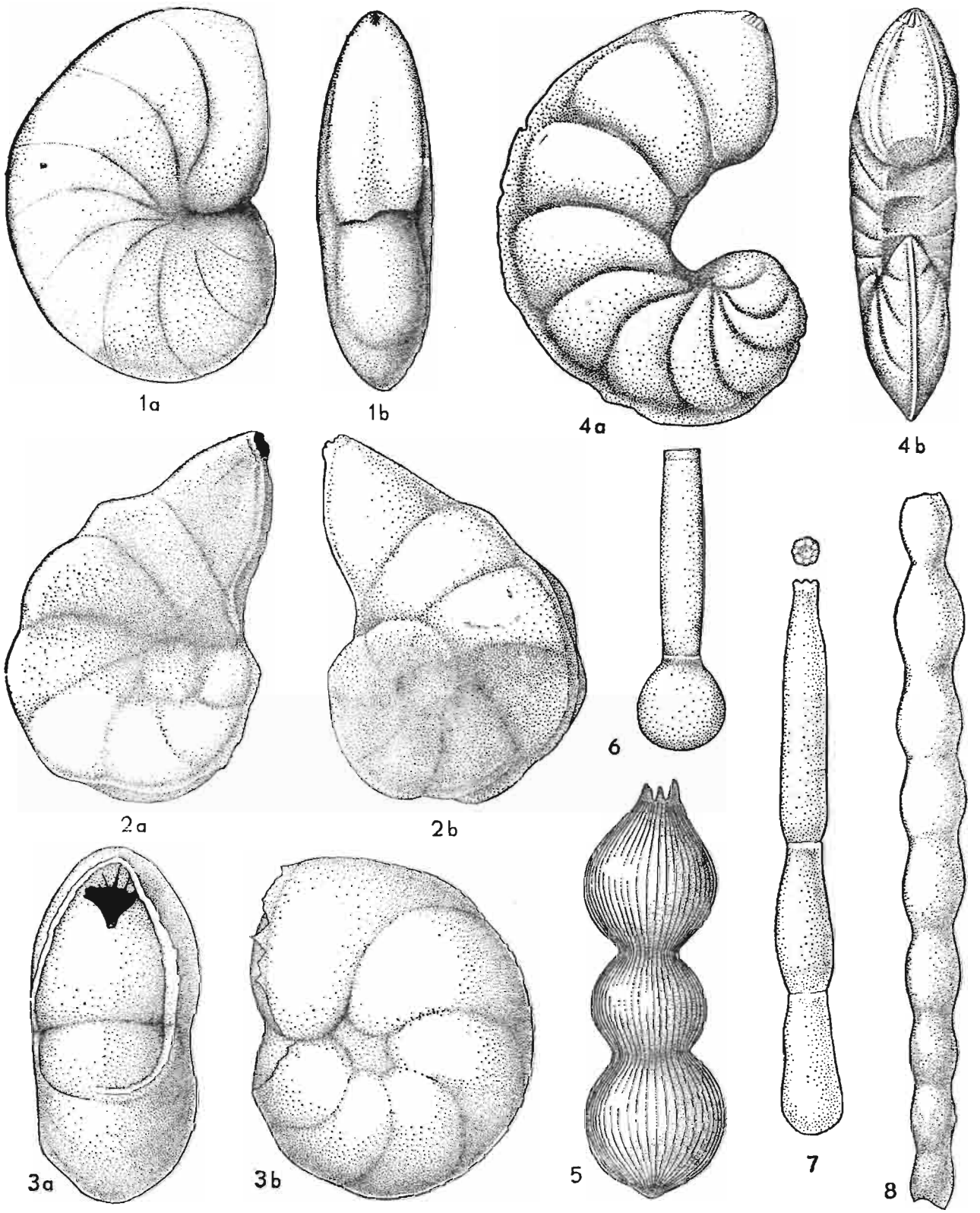

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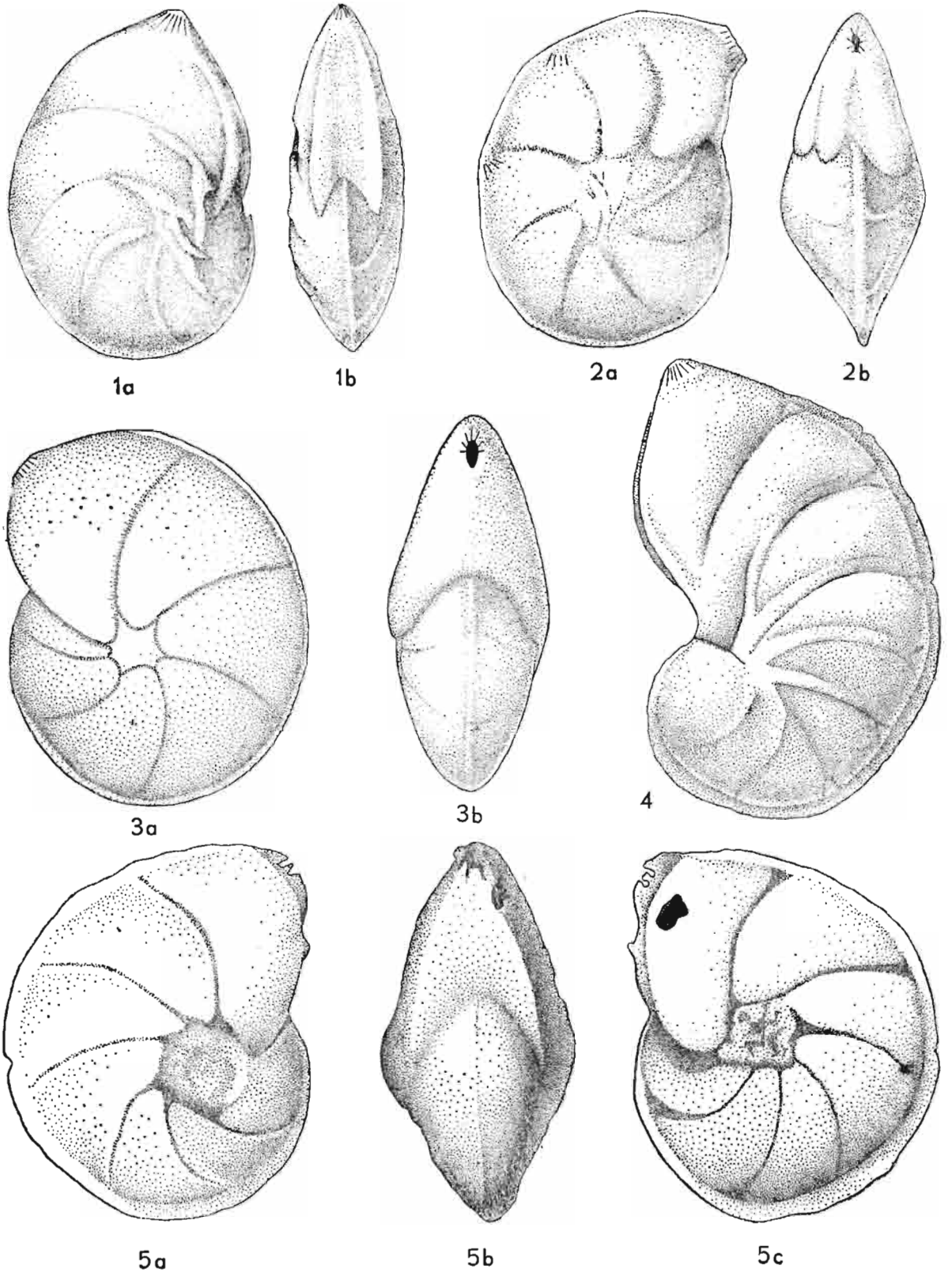

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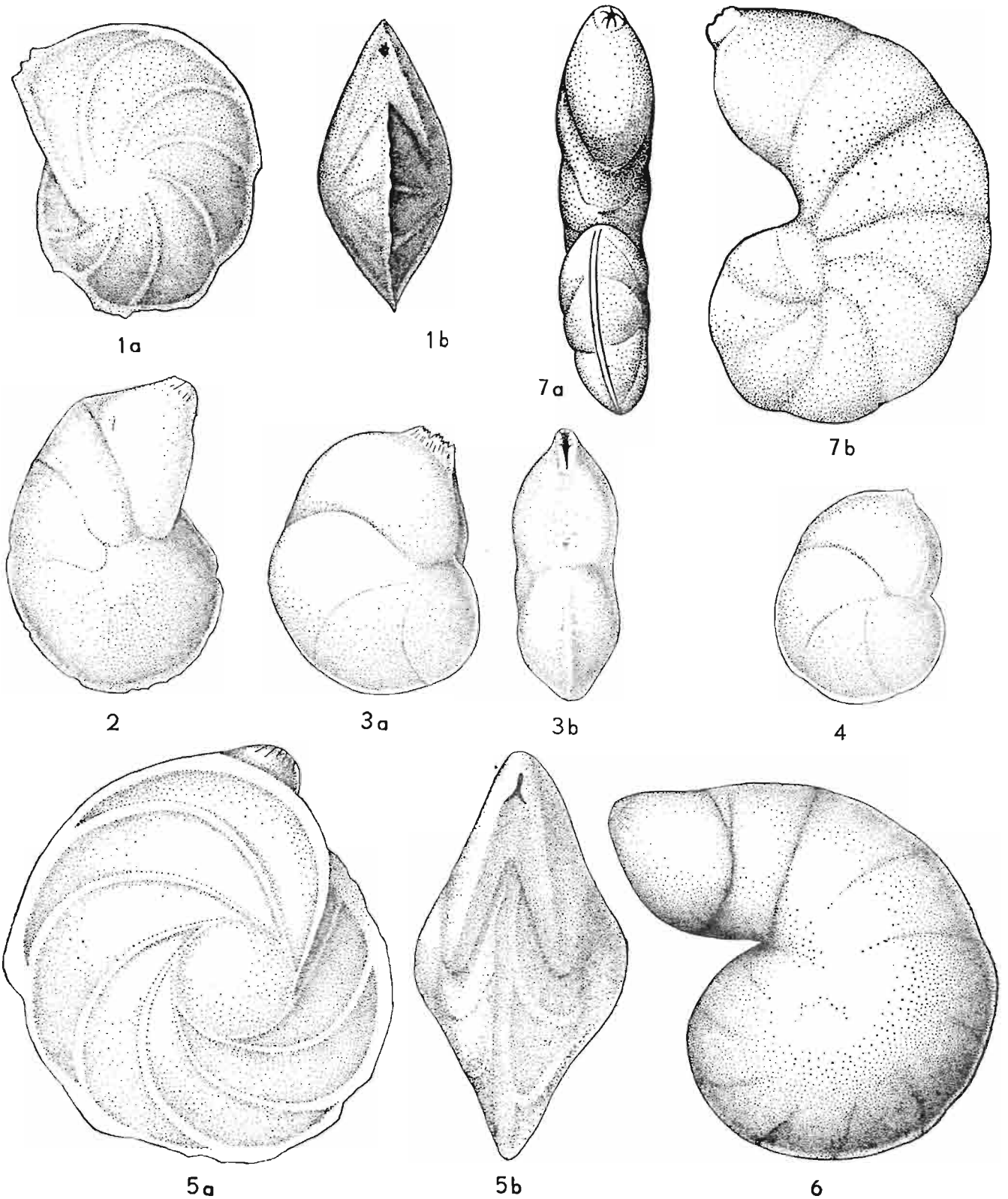
PLATE VIII



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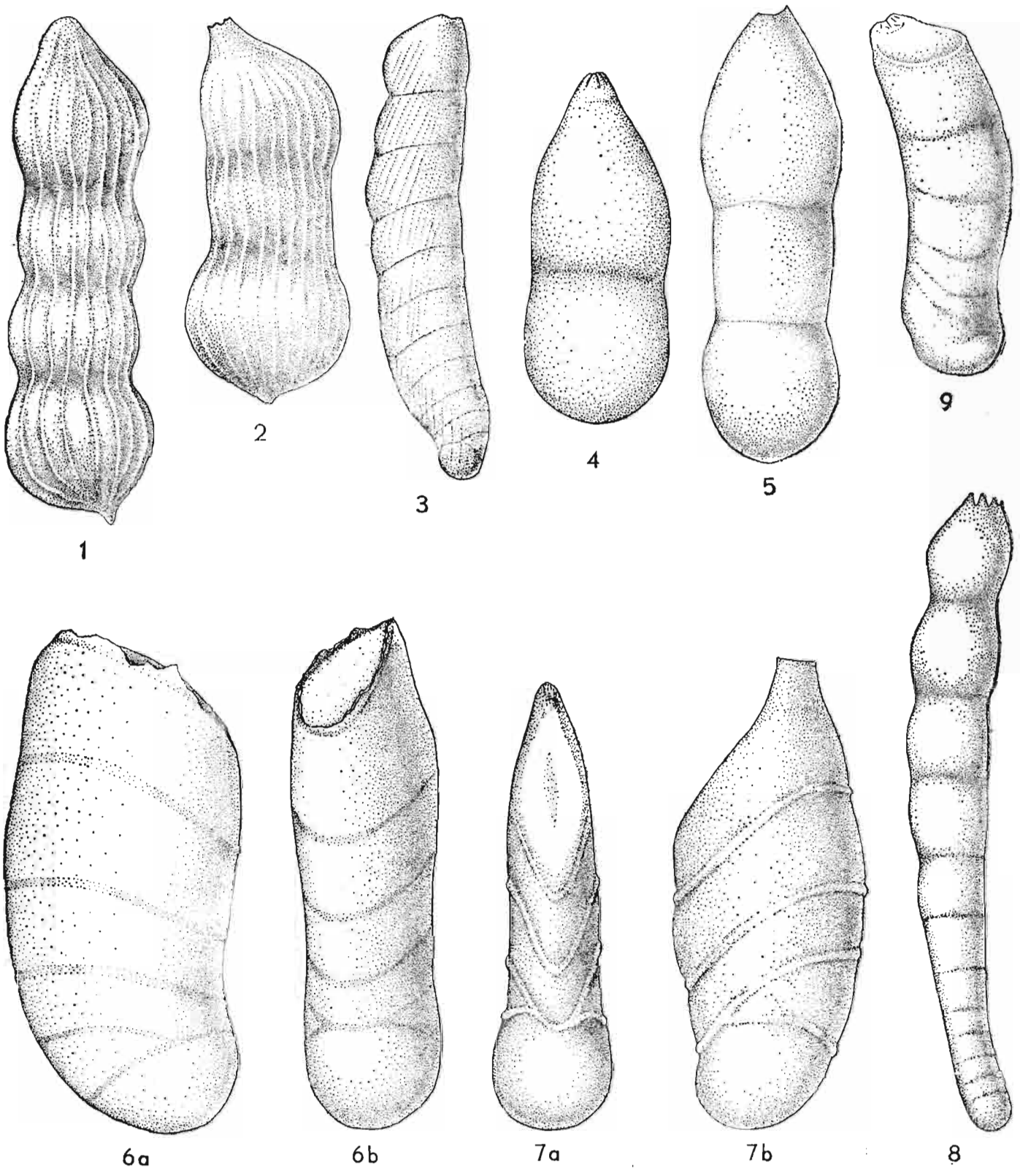

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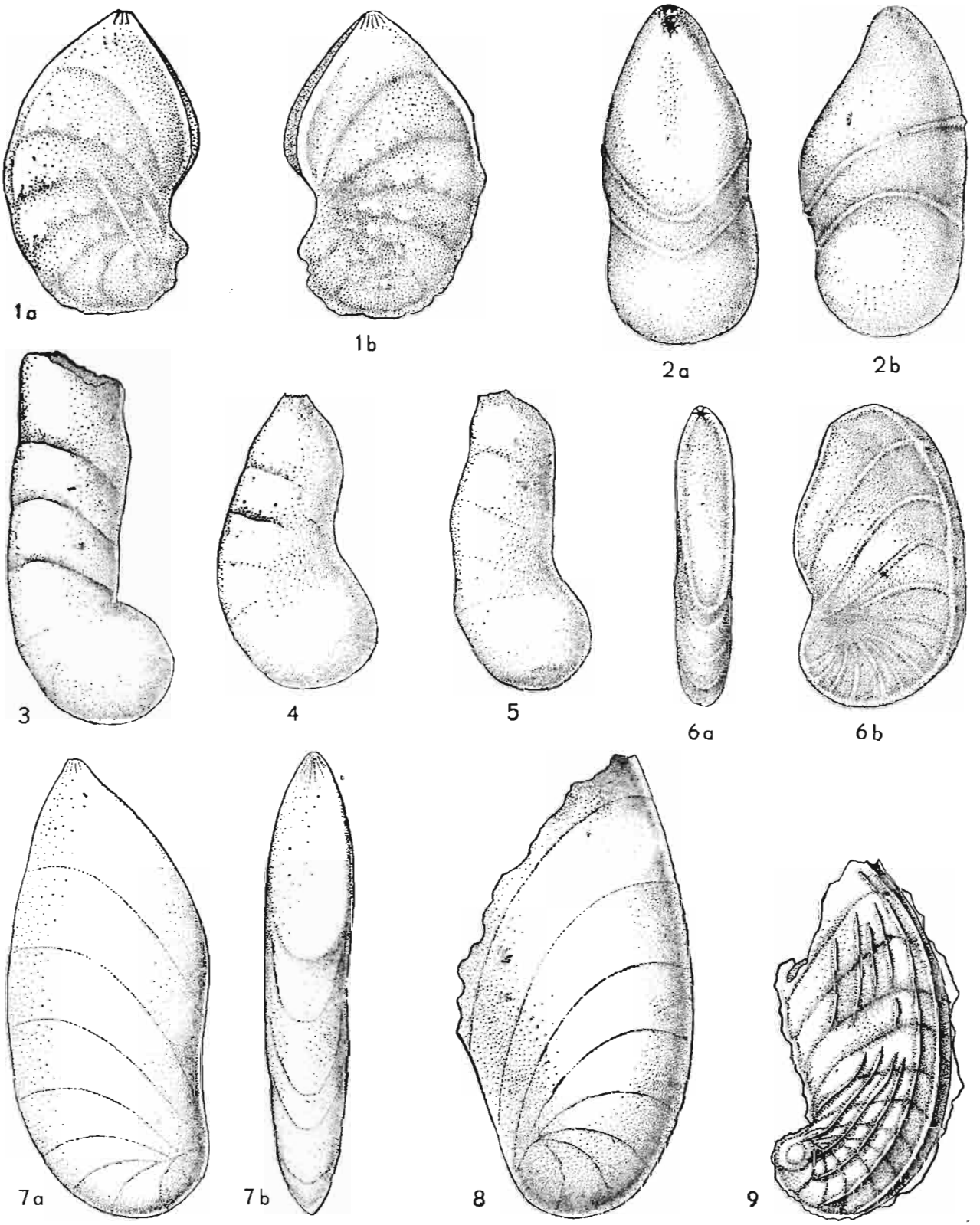

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Fig. 1. *Frondicularia biformis* MARSSON (F. VI/57), Nasiłów quarry, Montian; × 110 82
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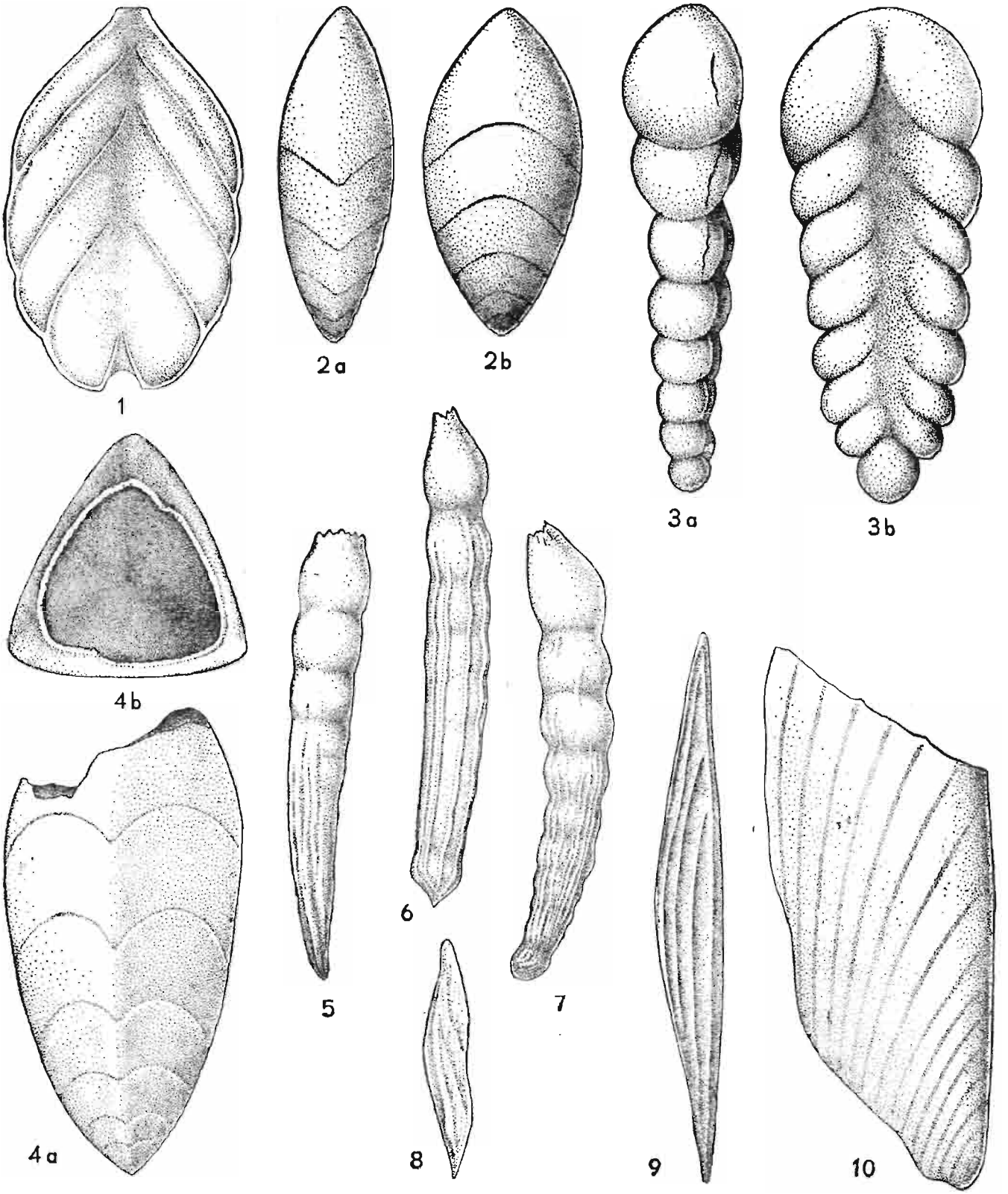

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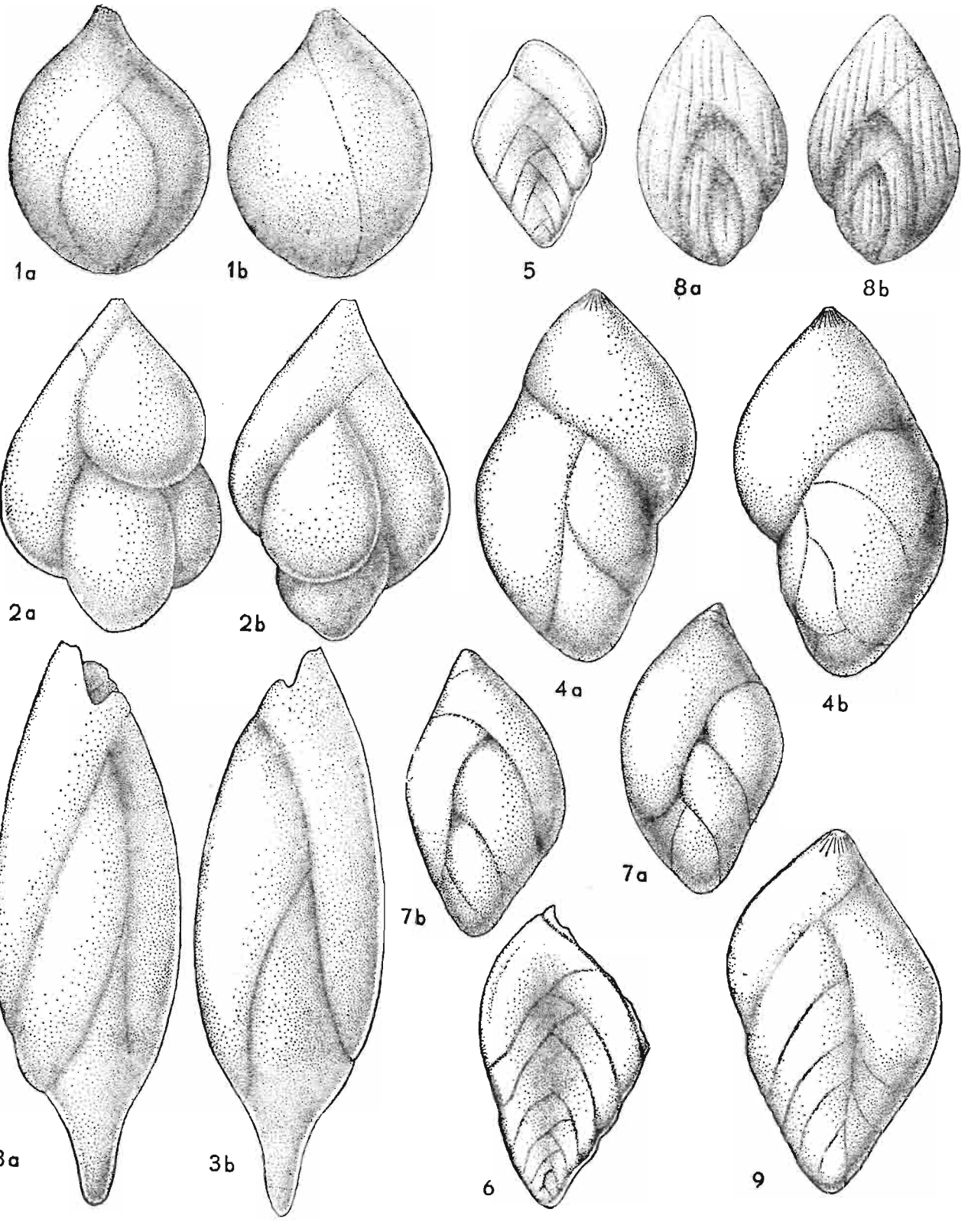

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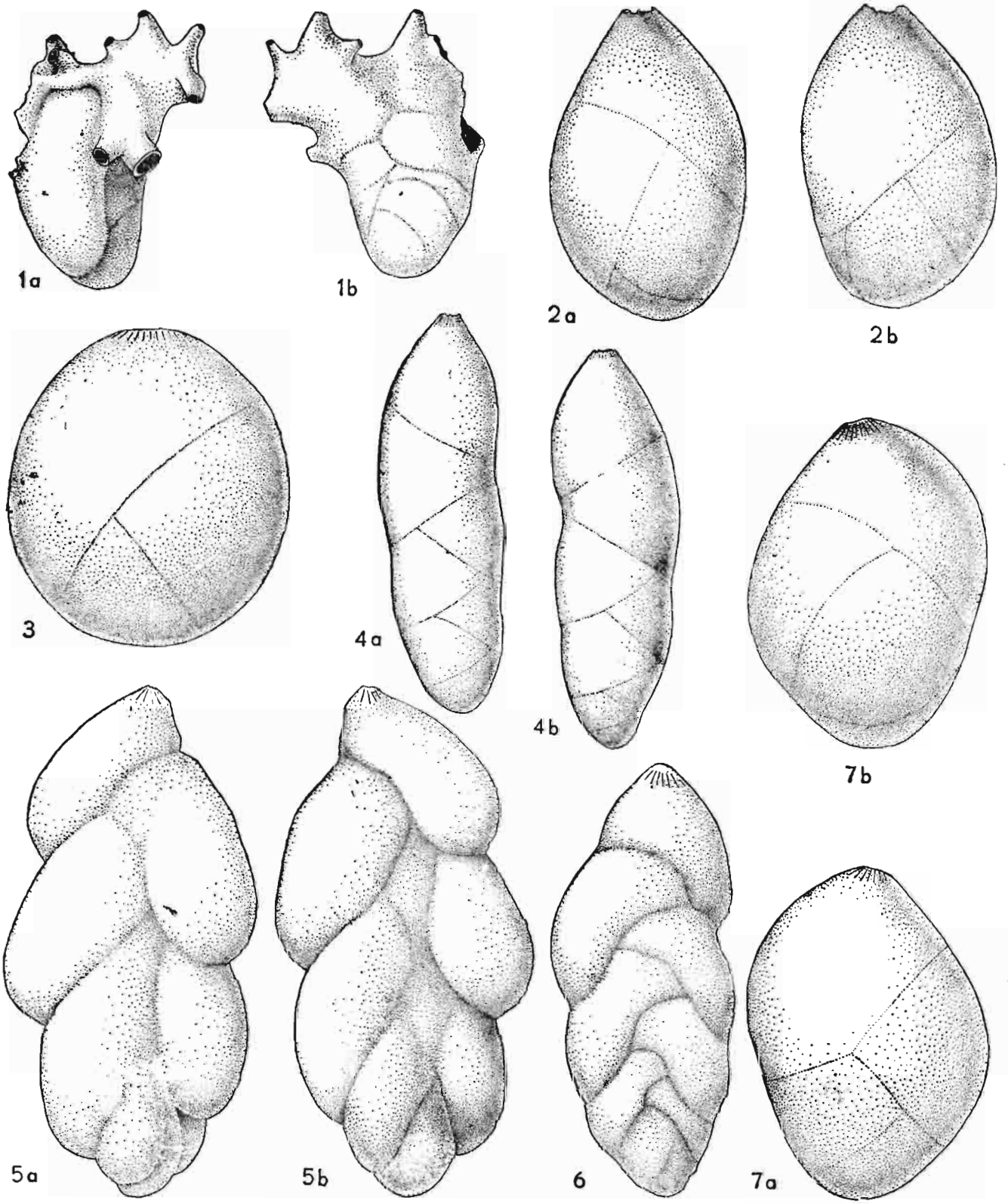

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K. POŻARYSKA: FORAMINIFERA AND BIOSTRATIGRAPHY OF THE DANIAN AND MONTIAN

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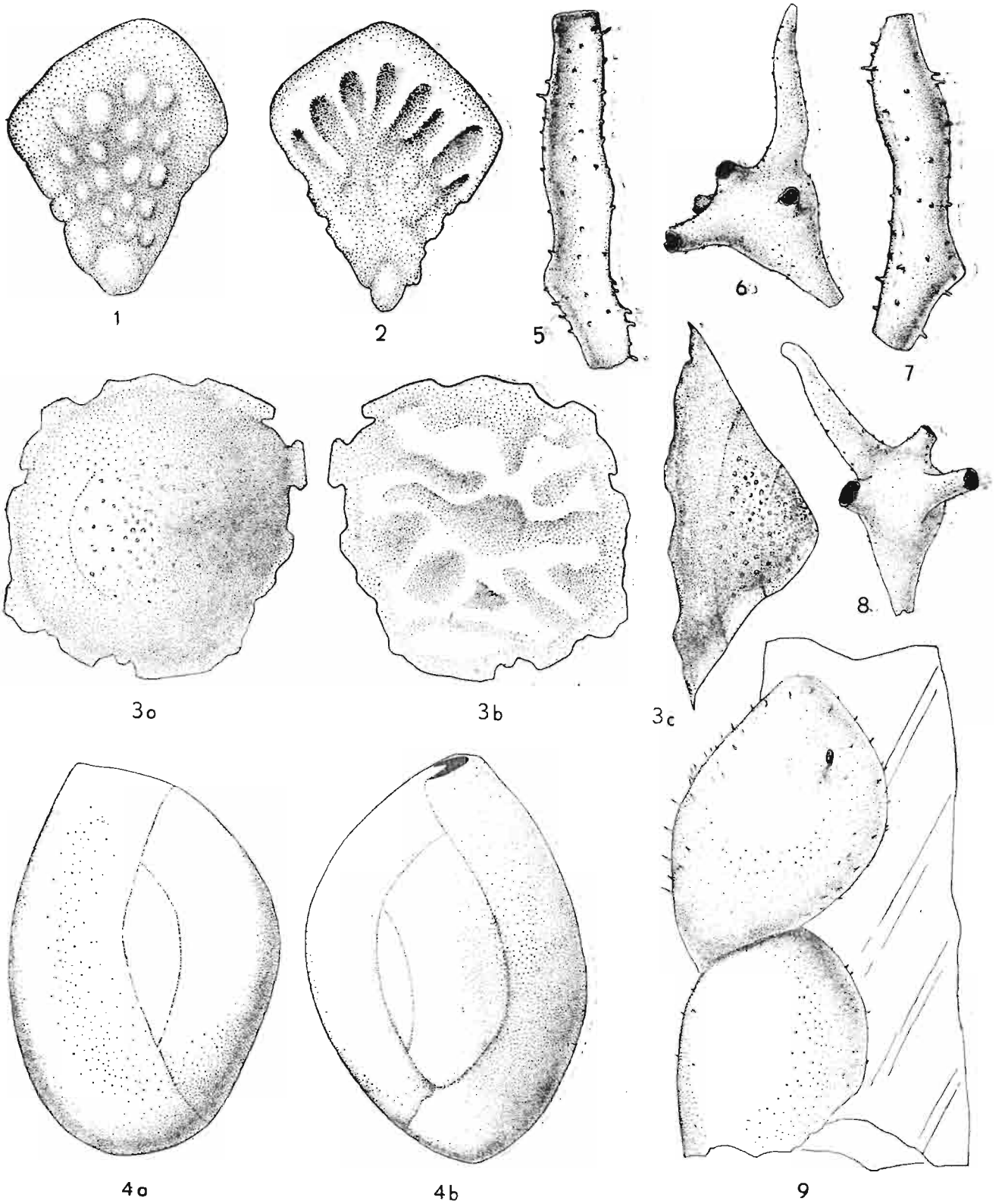

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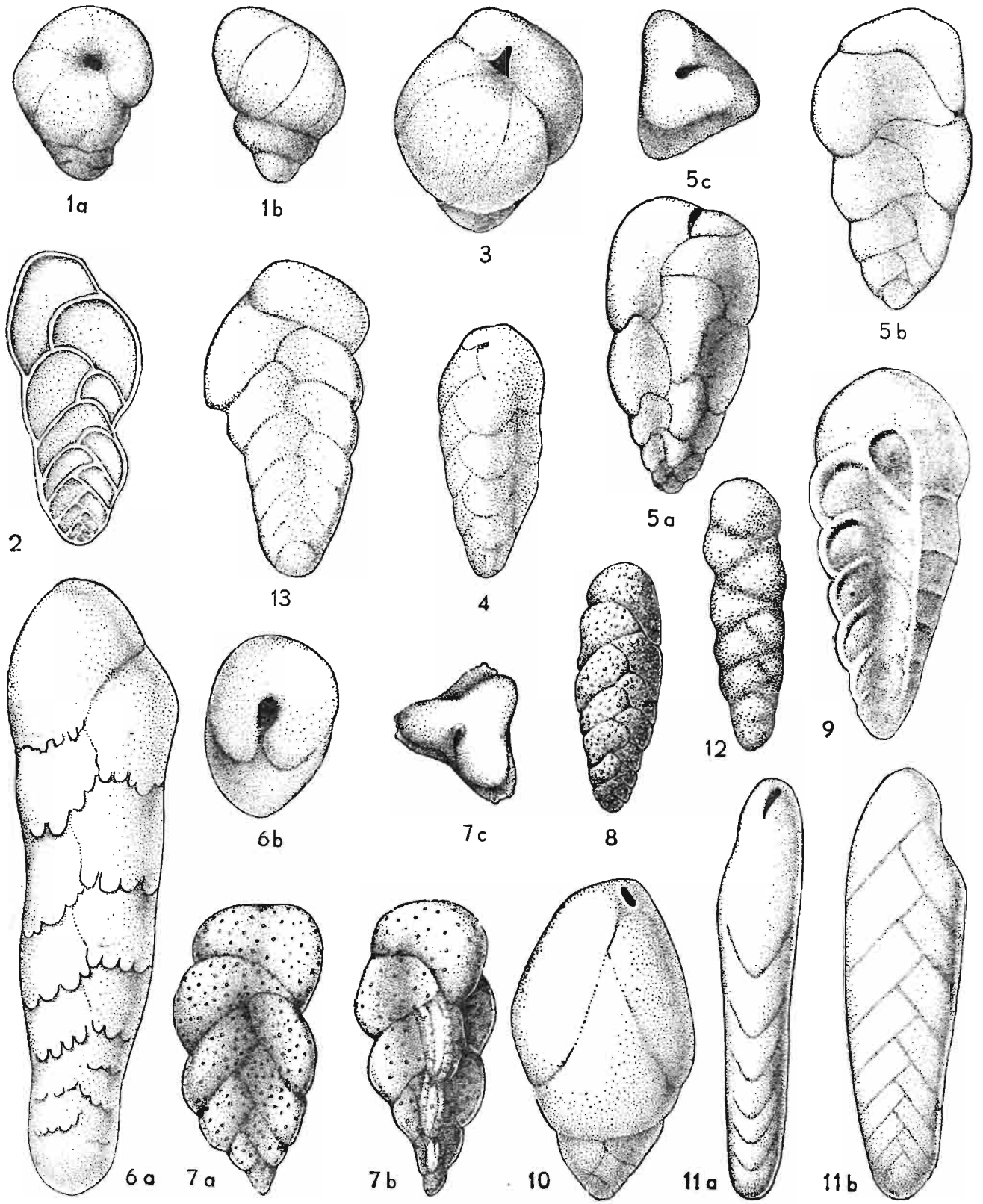

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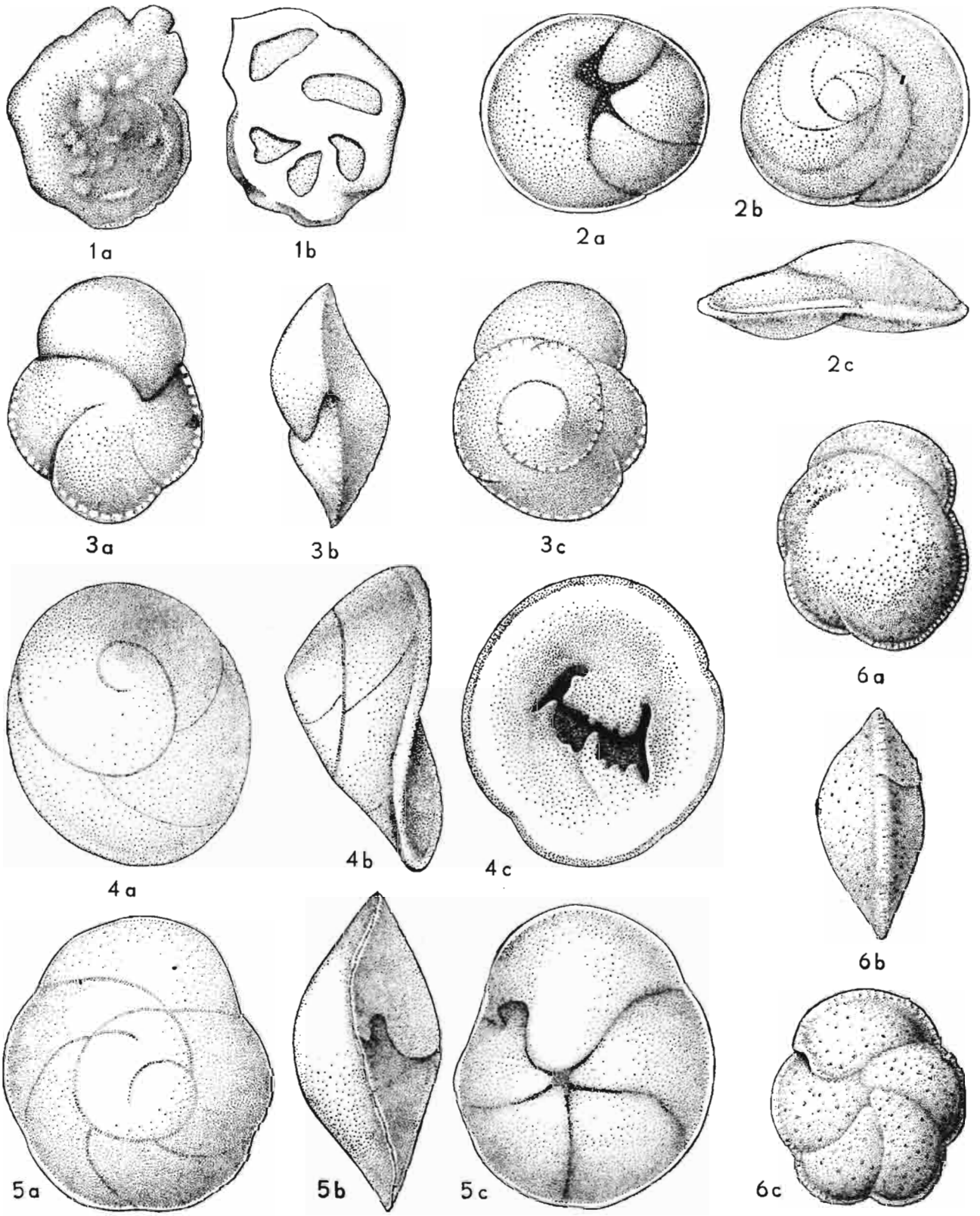

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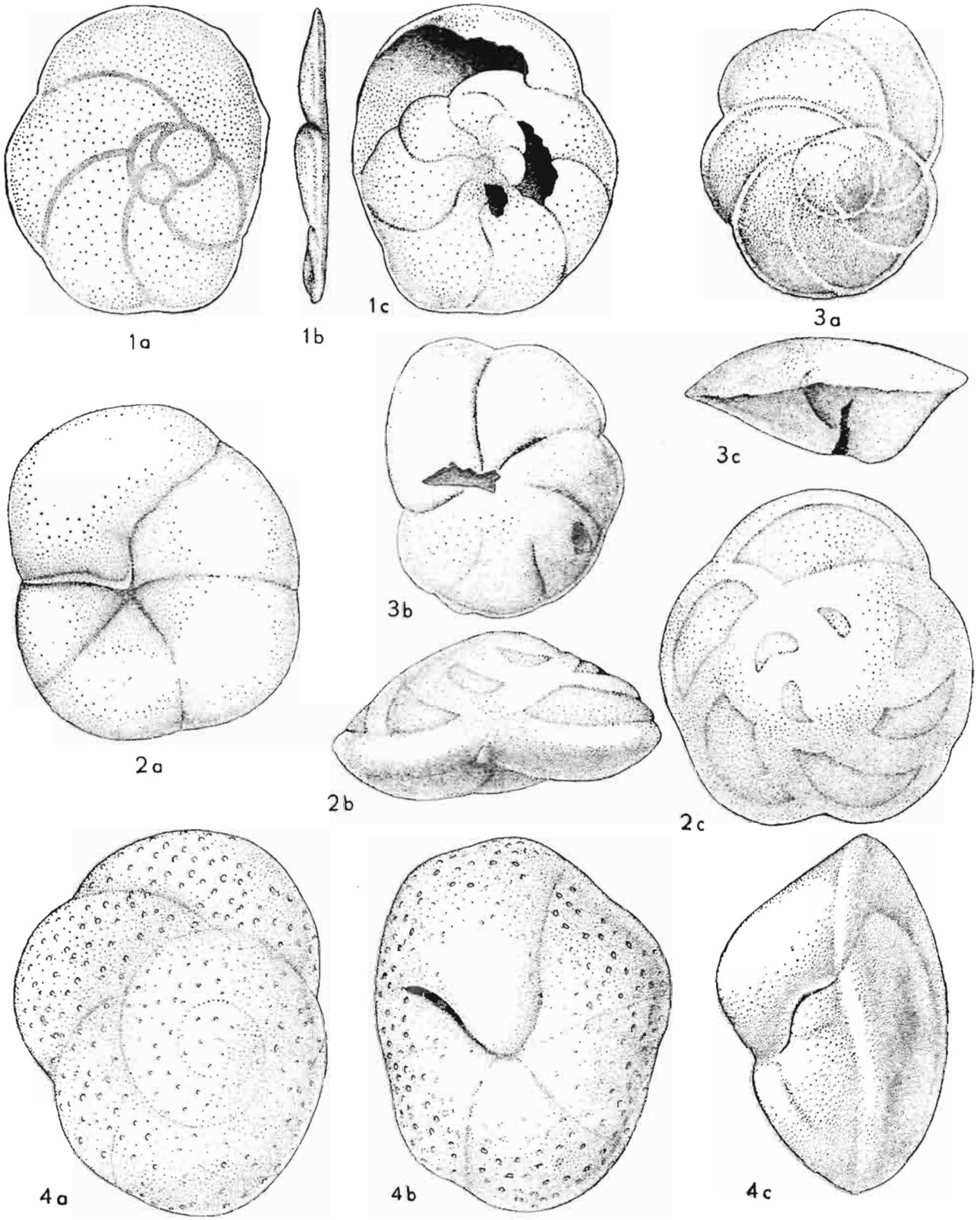

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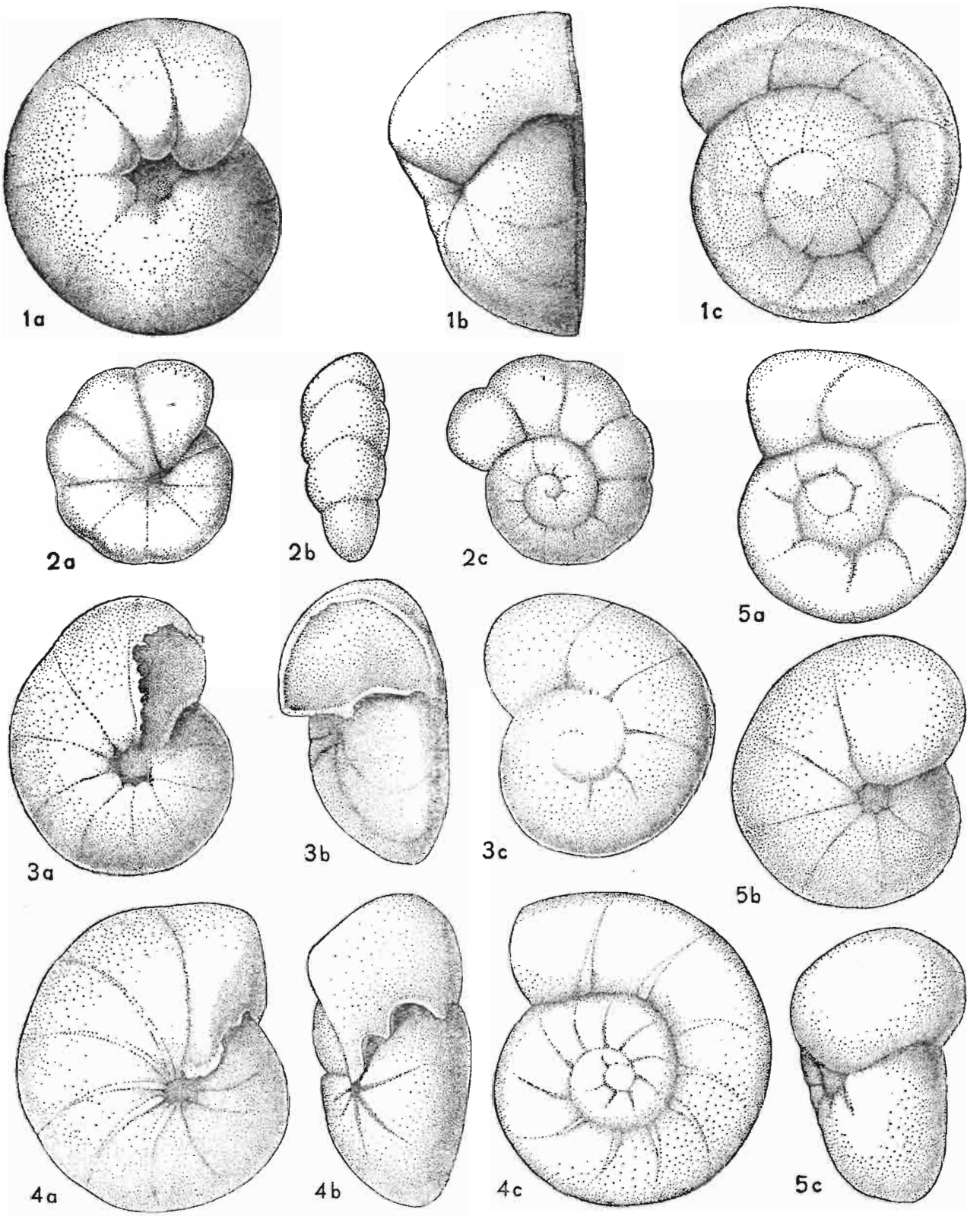

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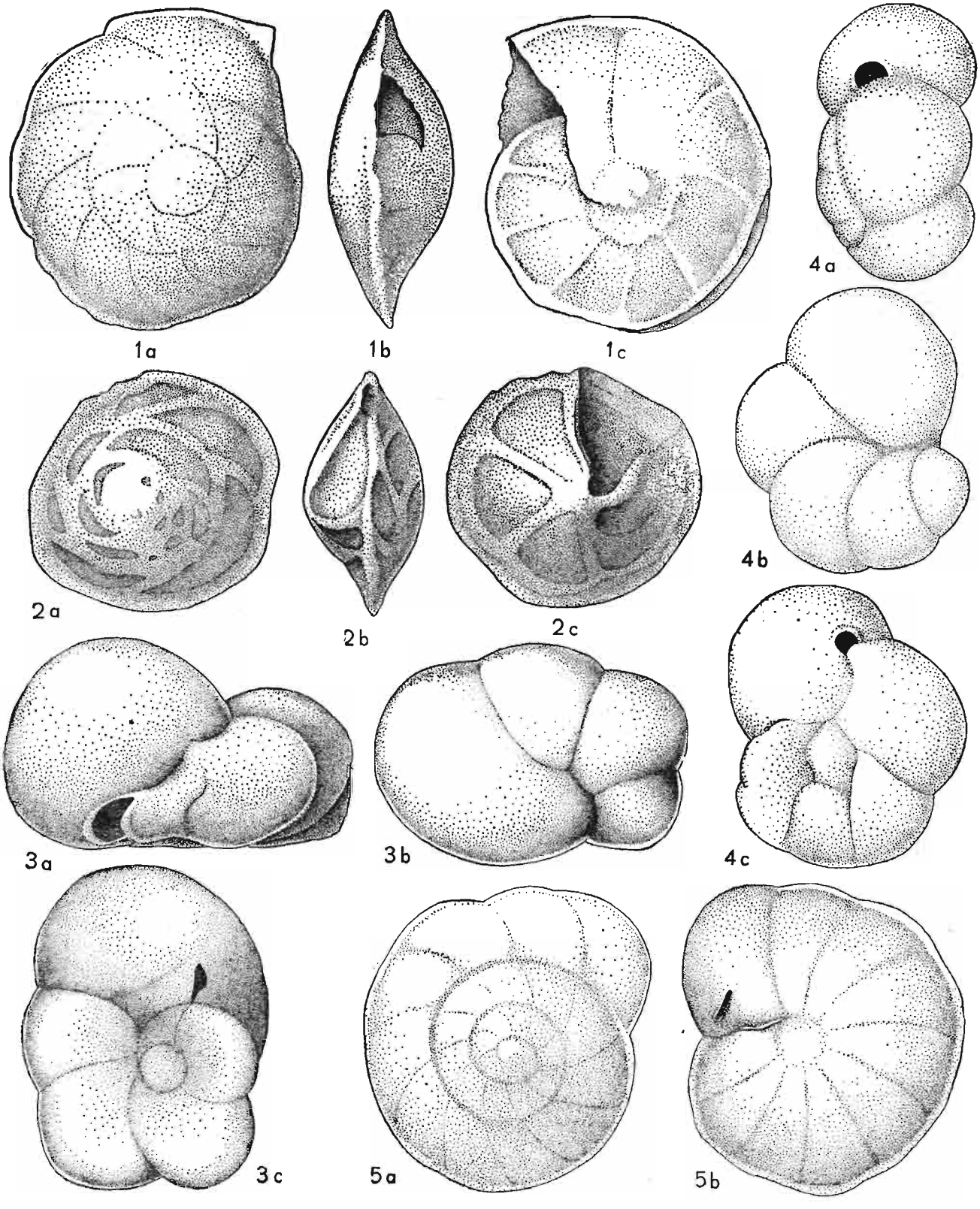

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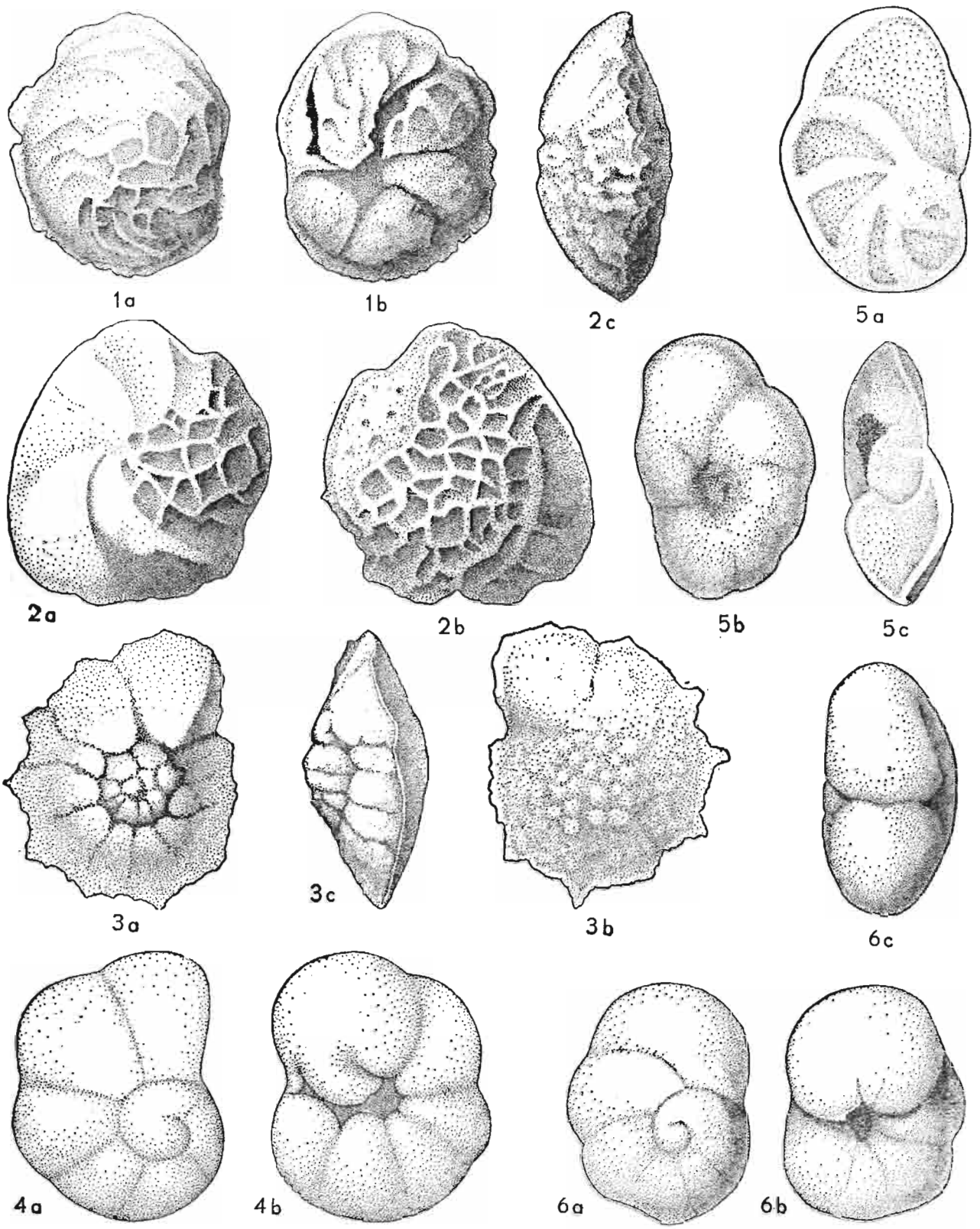

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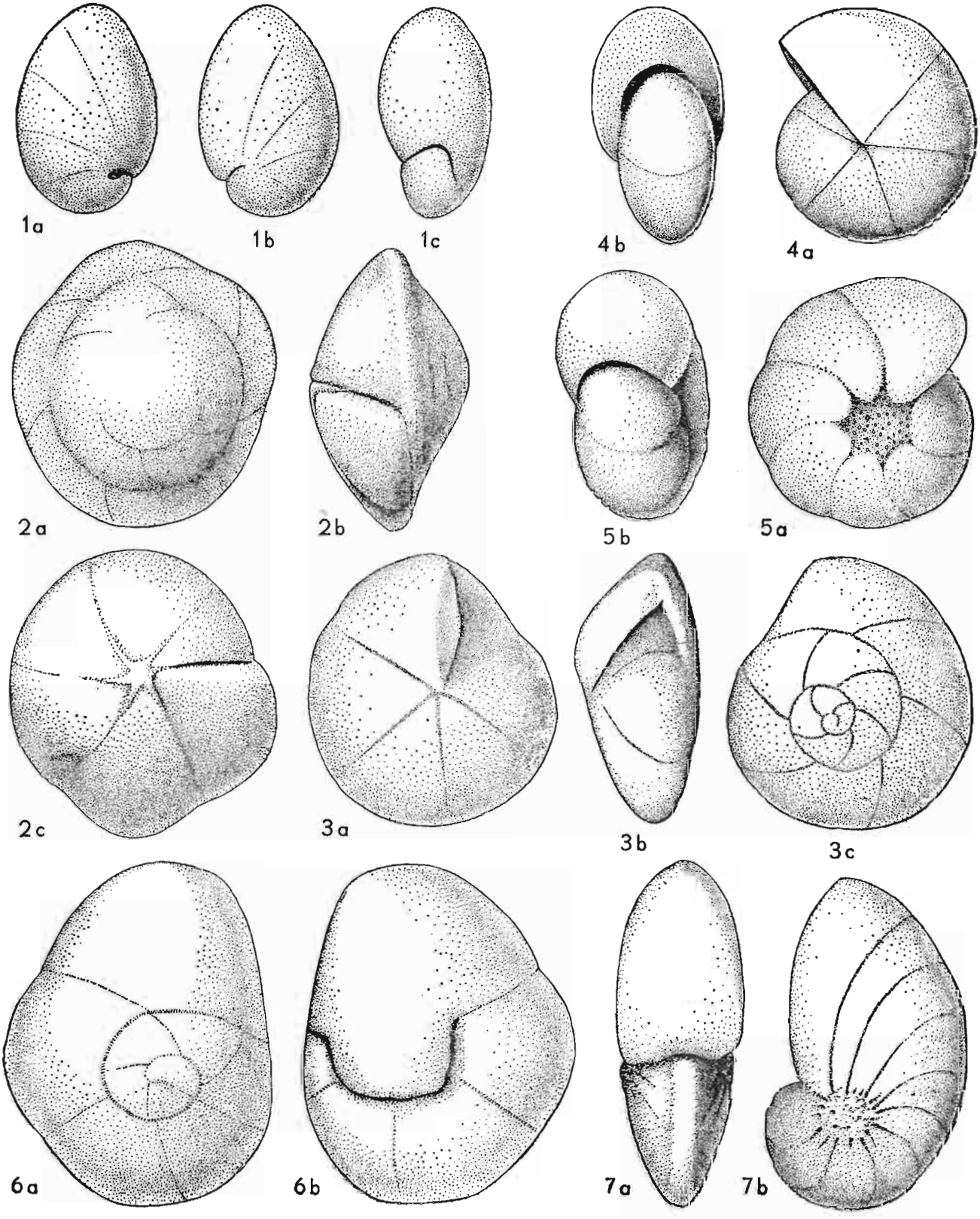

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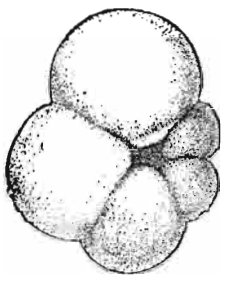

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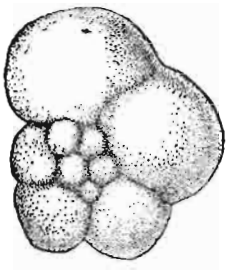

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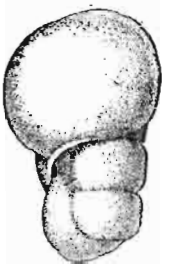

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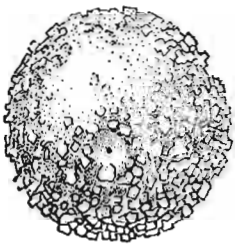

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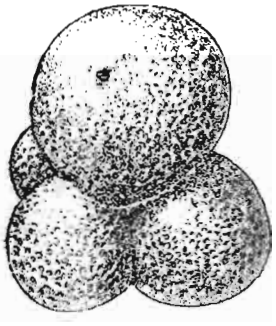

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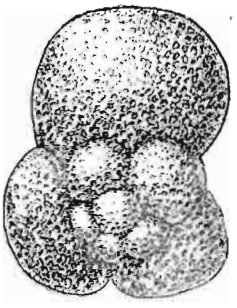

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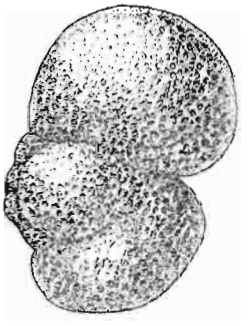

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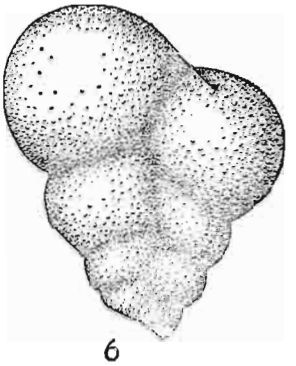

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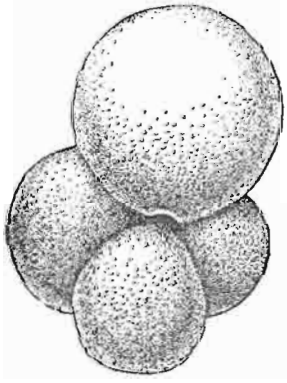

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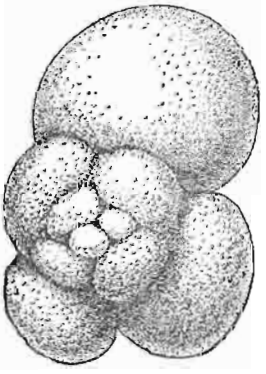

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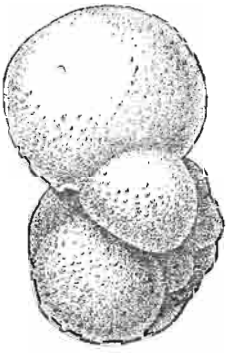

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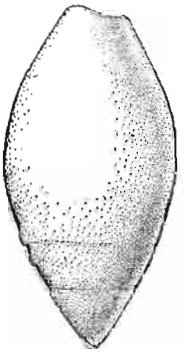

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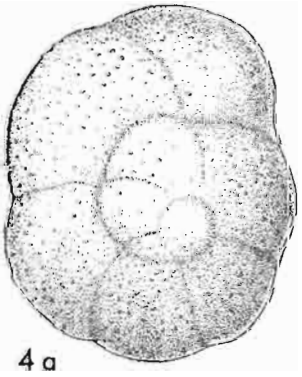

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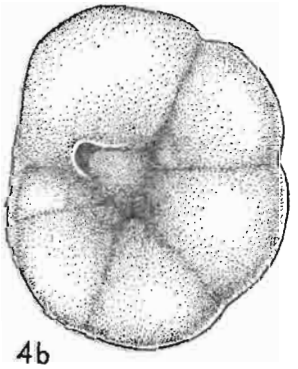

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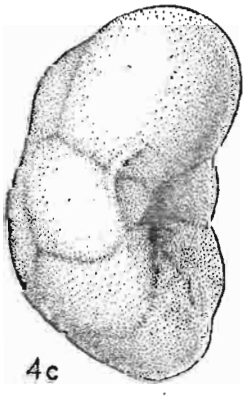

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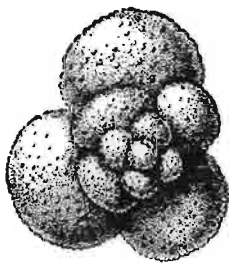

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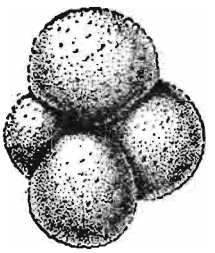

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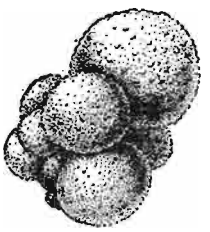

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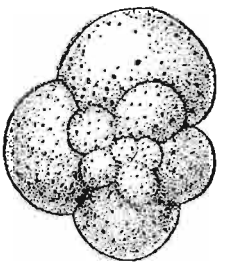

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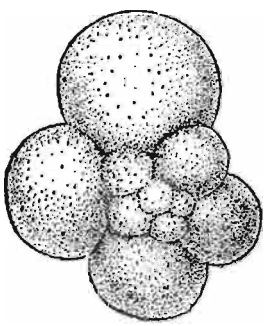

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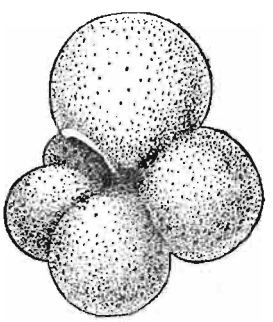

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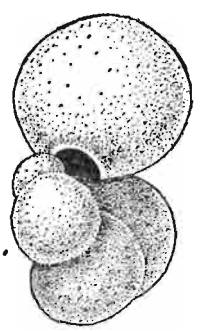

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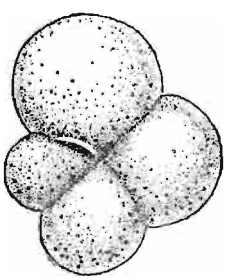

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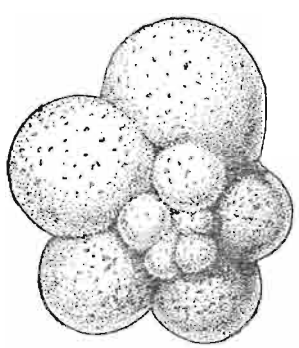

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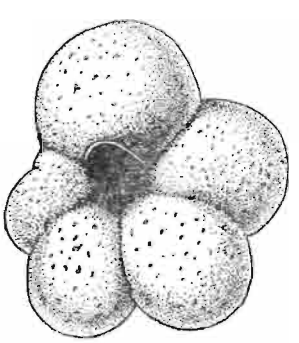

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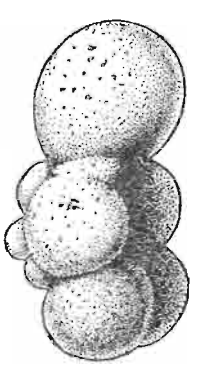

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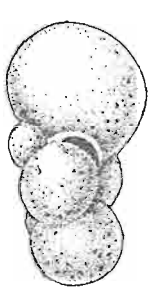

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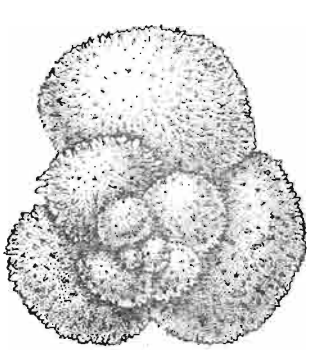

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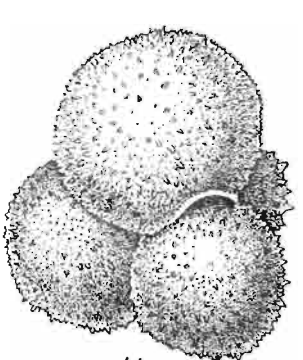

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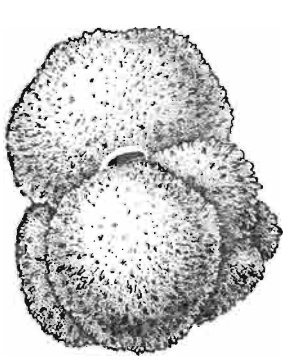

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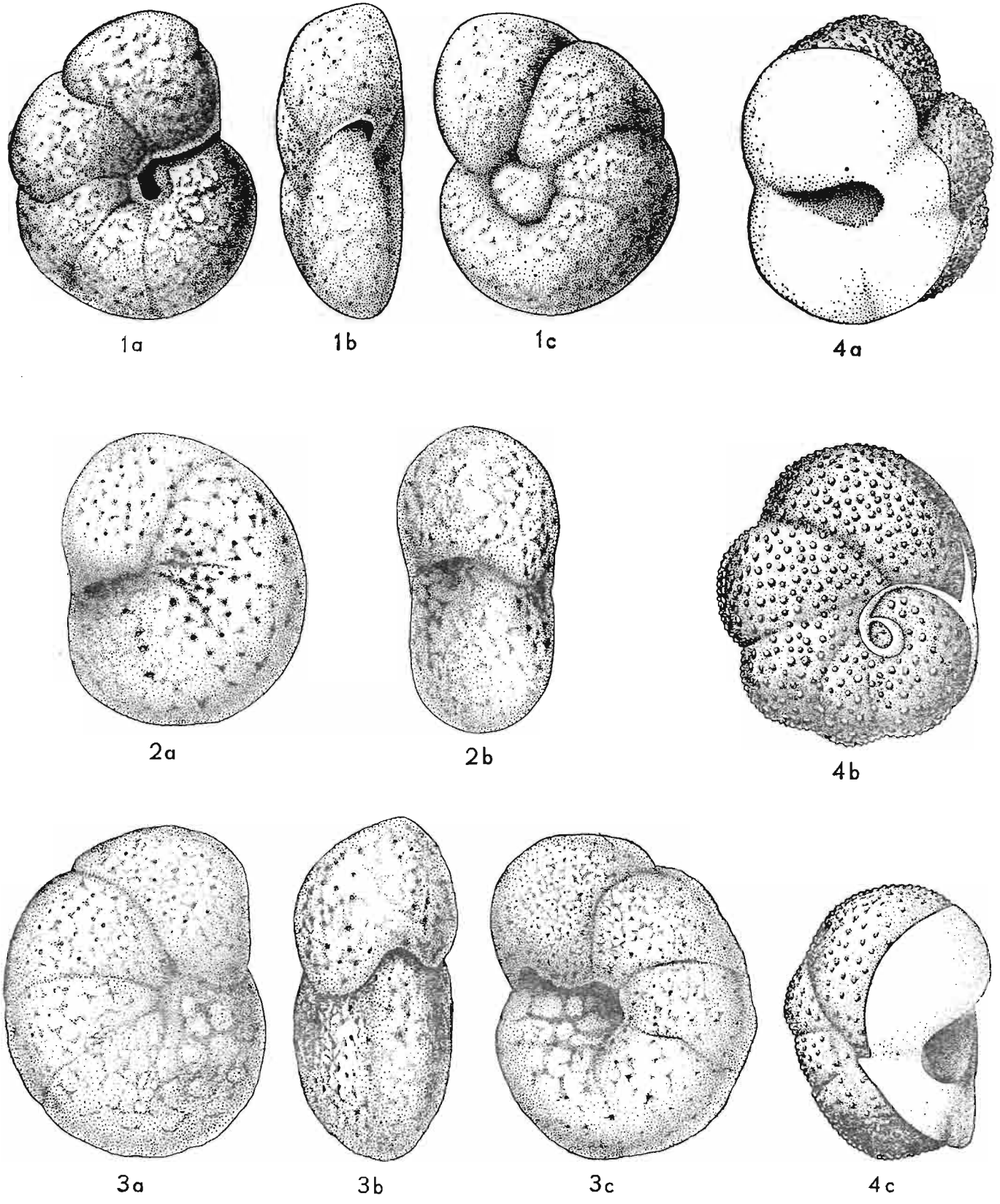

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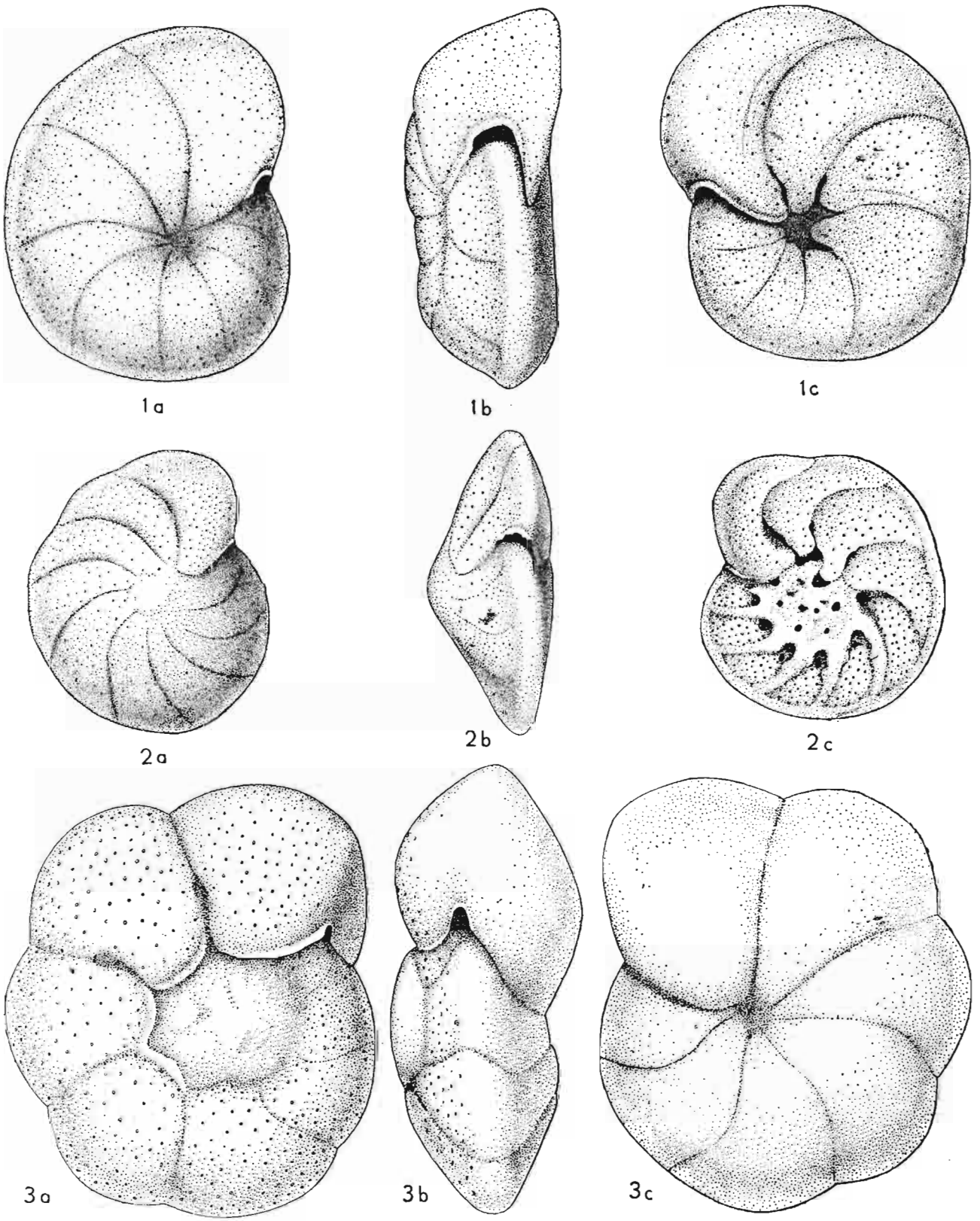

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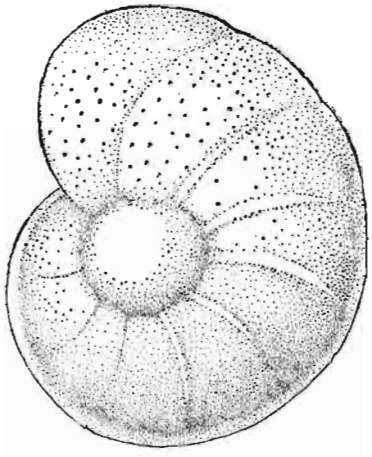

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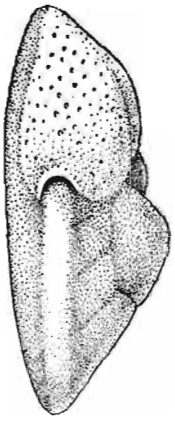

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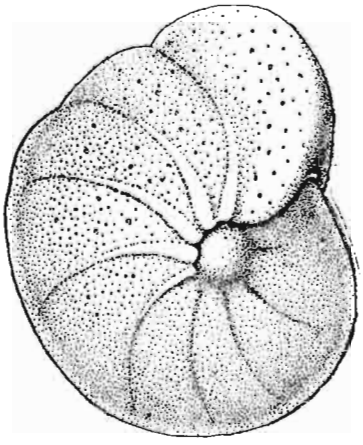

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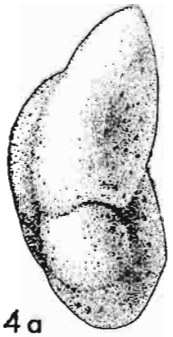

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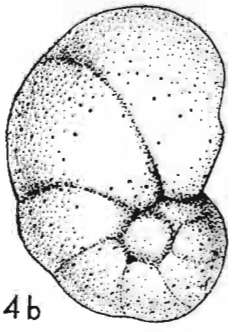

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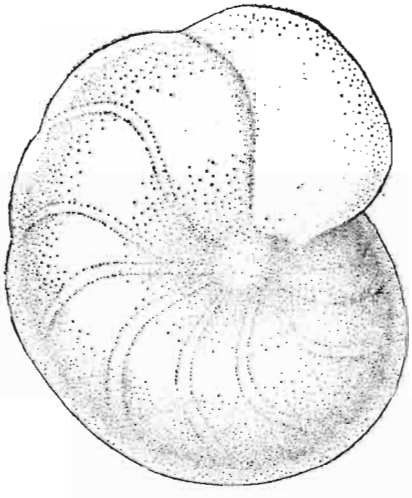

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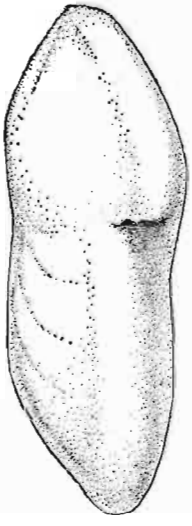

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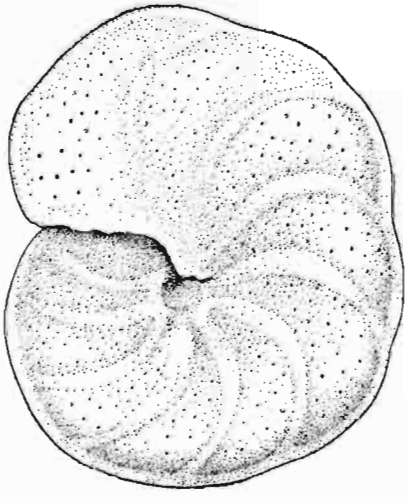

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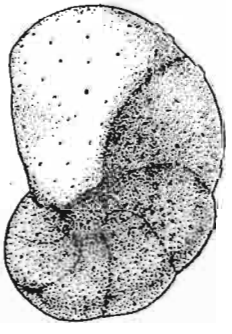

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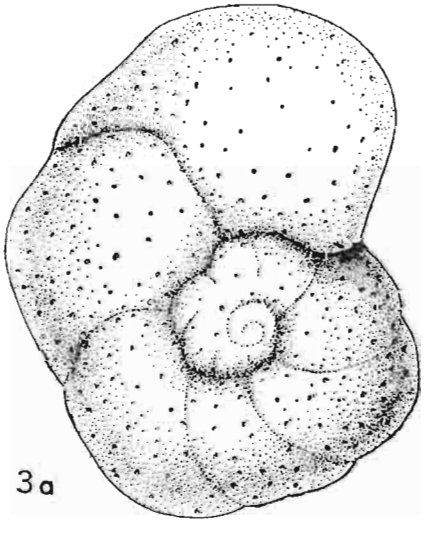

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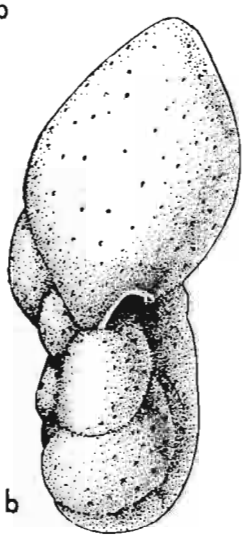

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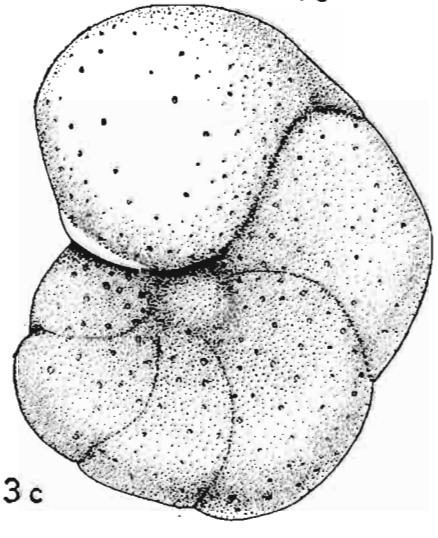

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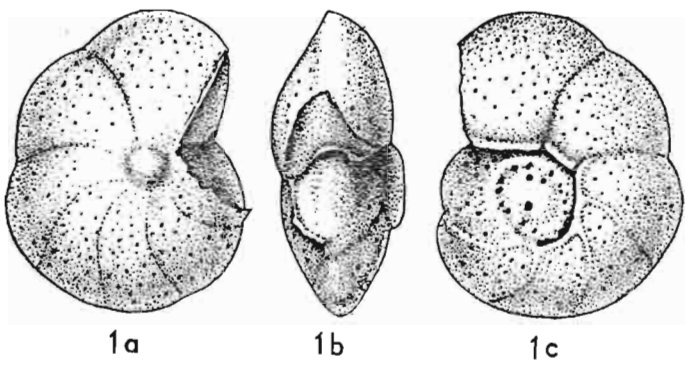

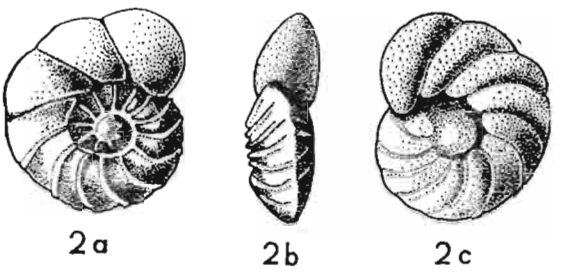

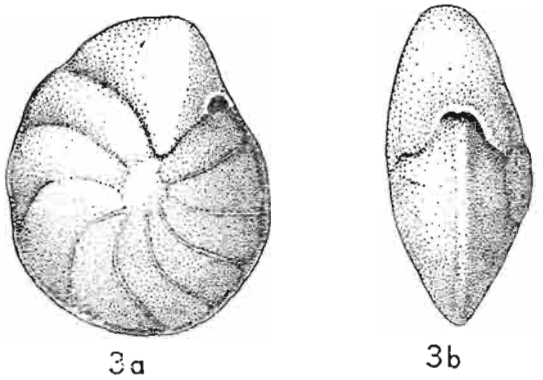

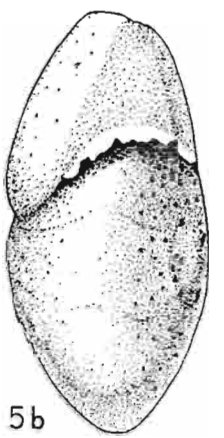

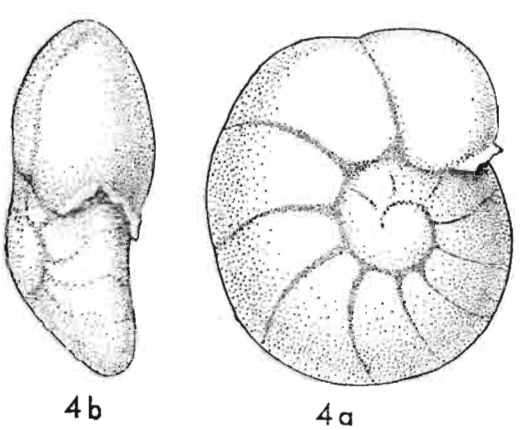

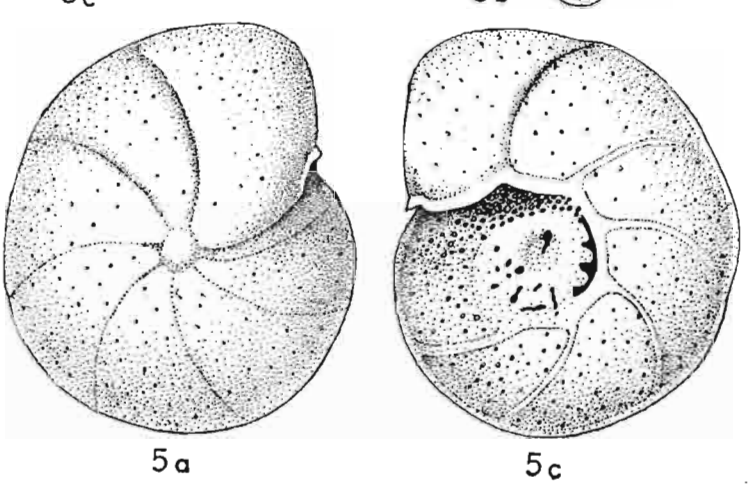

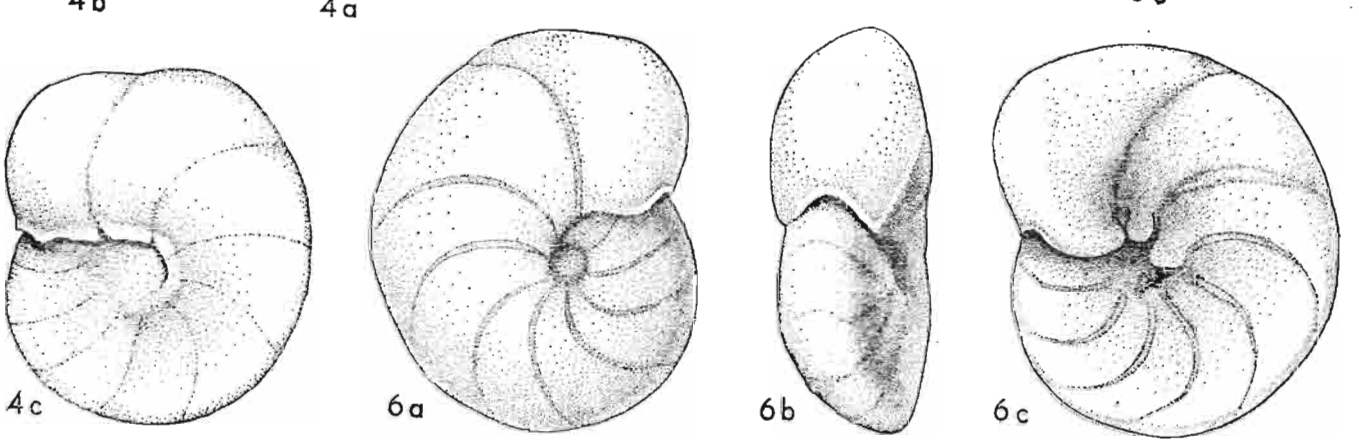

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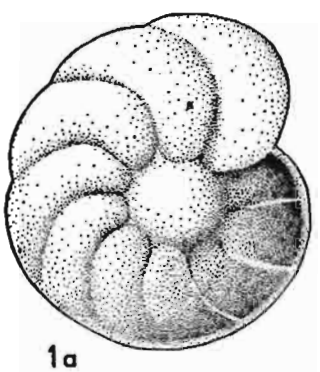
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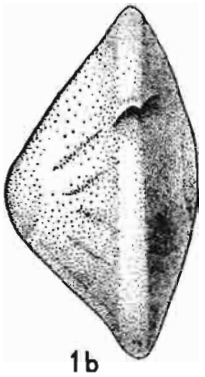
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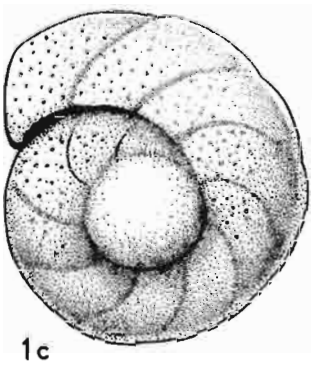
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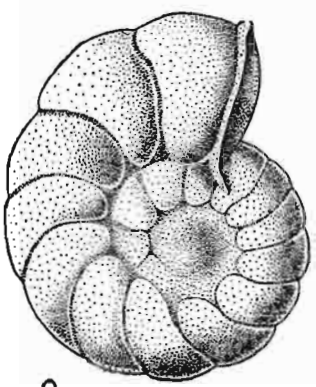
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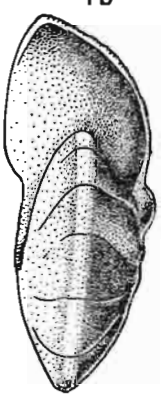
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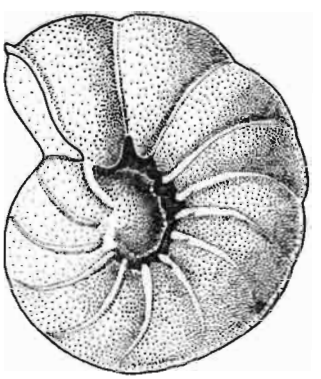
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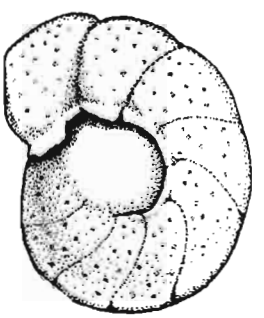
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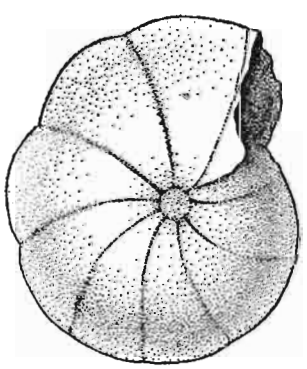
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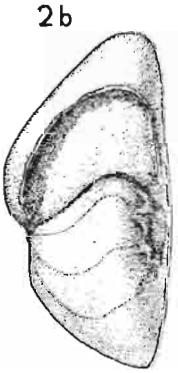
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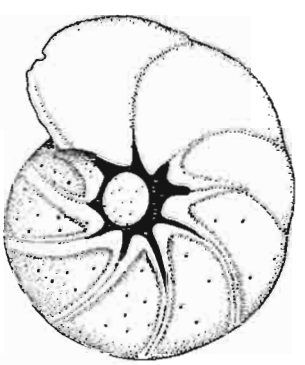
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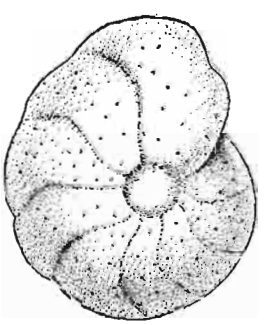
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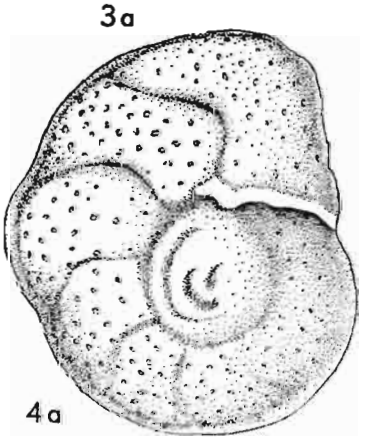
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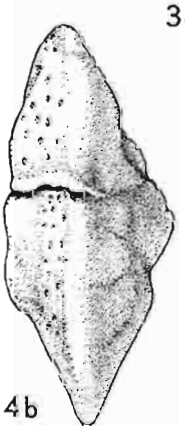
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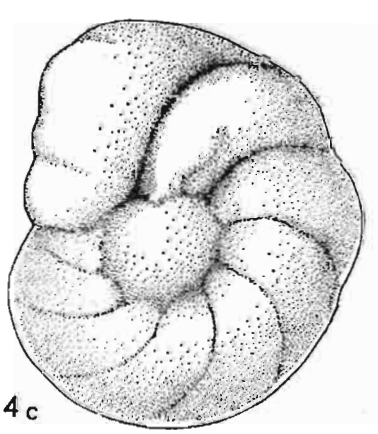
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